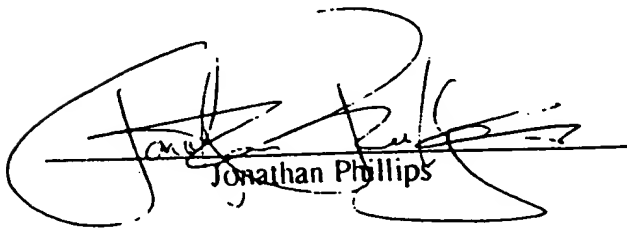


CONSULTING REPORT

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ADDITIONAL CALORIMETRIC EXAMPLES OF ANOMALOUS HEAT FROM PHYSICAL MIXTURE OF K/CARBON AND PD/CARBON

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CONFIDENTIAL



INTRODUCTION

Repeatedly during the period from June to October 1995 apparent 'anomalous' heat was observed using one class of catalytic materials supplied by HCP corporation. Specifically, heats were observed, calorimetrically, of a magnitude not readily explained by conventional chemistry when pure hydrogen streams of about two atmosphere pressure were passed over the catalytic materials. The successful catalysts in all cases were physical mixtures of two materials: carbon supported potassium nitrate and carbon supported platinum.

The current report regards efforts to test four hypotheses. First, that HCP has mastered procedures which insure anomalous heat can be repeatedly obtained. Second, to illustrate that the choice of the carbon employed as a support has a small, but measurable, impact on the procedure for generating anomalous heat. Third, to demonstrate that the choice of noble metal can also marginally impact the process.

The fourth hypothesis is more complex. It is that the model of potassium transformation postulated in earlier reports is correct. That model consists of three parts. (i) Potassium nitrate is gradually reduced to potassium metal in the cell during the time that anomalous heat is observed. (ii) Once the potassium is fully reduced, heat evolution ceases. (iii) Potassium oxide (KO_2 or KOH) only forms upon air exposure. Tests were designed to allow the testing of this model using weight loss, calorimetric measurement of heat evolution from oxygen exposure after catalyst de-activation, and x-ray studies.

Three samples were studied. The first sample discussed in this report was different than those studied previously for two reasons: (i) the support was changed to a commercial 'charcoal', (ii) the noble metal in the mix was palladium rather than platinum. The other two samples were prepared on the 'standard' support material, Grade GTA Grafoil (Trademark, Union Carbide), a moderate surface area, high purity, graphitic material. However, changes were made in the composition of these catalytic mixtures as well. Carbon supported palladium, rather than carbon supported platinum, was mixed with these samples.

All three samples produced 'anomalous' heat. On the basis of these results it is clear that HCP has developed procedures which allow the repeated observation of 'anomalous' heat, which can be observed in different laboratories. Yet, it was found that the identity of the support material does impact the result. In order to obtain anomalous heat from a charcoal supported sample it was necessary to operate at a higher temperature. The use of palladium rather than platinum also appears to have some impact. The two graphite supported samples contained palladium almost immediately produced heat upon the introduction of hydrogen at 125 C. Generally with platinum containing mixtures there was a lengthy 'induction' period, and in most cases a temperature higher than 125 C was required to insure the observation of anomalous heat.

Some NOVEL tests were carried out with the two Grafoil supported samples to test the model of potassium transformation. Specifically, careful measures of weight loss and careful calorimetric measures of heat evolution (only one sample) during oxygen exposure of the deactivated catalyst were carried out. The values obtained were in close agreement with the postulated transformations. Specifically the weight loss and the heat observed during oxygen exposure of the deactivated catalyst were near values anticipated on the basis of the model and the x-ray results.

In sum, the present results contain two important findings. First, HCP can produce catalysts which repeatedly yield anomalous heat, and second, the model of potassium transformation is consistent with all measures. The latter finding has particular significance as it gives additional credence to the claim that anomalous heat is observed. Indeed, the heat anticipated for the over-all conversion of KNO_3 to KO_2 or KOH , even accompanied by the creation of water and ammonia, is only weakly exothermic. The actual heat observed was significantly more than that anticipated from conventional chemistry. If these findings can be repeated (twice) and if DIRECT evidence of the conversion of the potassium to a zero valent state during hydrogen flow can be obtained (e.g. *in situ* x-ray) these findings can be made the basis of an article for the peer-reviewed scientific literature.

It must be emphasized that calorimetric measures alone are somewhat ambiguous and that *in situ* x-ray studies are strongly advised before sending the material for publication. It is also recommended that 'control studies' be carried out. In the absence of a noble metal it is likely that potassium nitrate will follow the same decomposition course, but the process should yield an endotherm, rather than a strong exotherm.

Finally, it must be noted the results of even the most careful calorimetric, x-ray and weight change experiments will not serve as a proof of the existence of hydrinos. Results from our lab will only provide strong evidence that heats higher than predicted by conventional chemistry are observed in the dry HCP cells.

EXPERIMENTAL

All experimental procedures and equipment was identical to that described in earlier reports with two exceptions: (i) a new BLUE M furnace was employed, (ii) a gas sampling system on the exit line was employed. Neither change should have any impact on the calorimetric studies.

RESULTS

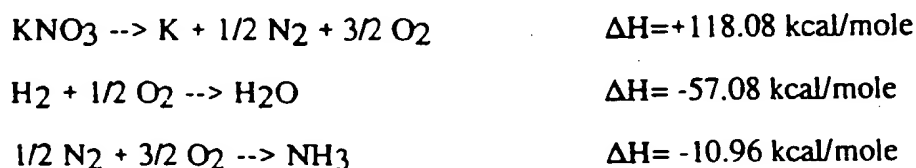
SAMPLE 111395A - The sample contains 5.9567 gms of total material, and was nominally 43 percent by weight potassium nitrate (2.56 gms or 0.0253 moles KNO_3). The support in this case was an activated charcoal obtained from Alpha Chemical. Charcoal loaded potassium made up 97% of the material, and the remaining 3% of the material was carbon supported palladium.

Previous experience with these samples at HCP indicated that heat is only observed at 200 C. Thus, after testing the calorimeter (Fig. 21-1) and baseline stabilization at 200 C in flowing helium (Fig. 21-2) hydrogen was introduced at 200 C. Almost immediately, a peak characteristic of hydride formation was detected (Fig. 21-3).

The signal decayed more gradually than usual for 'hydride' formation, and in fact, before reaching the original baseline the signal strength began a sharp climb in value. As shown in Figure

21-4 about 18 K seconds after hydrogen was first admitted the signal strength increased. In fact, about 24 K seconds after the increase began the signal saturated the amplifier (Figure 21-4). In fact, for almost 28 K sec. (approx. 7.5 hrs), the signal strength was higher than that computed for complete hydrogen conversion to water (0.24 Watts at a total flow rate of 2.16 ml/min at 300 K and 1 atmosphere of pressure). As usual, the signal gradually decayed to zero (Figs. 21-5,6,7).

The total heat produced before the signal decayed to zero was at least 23.4 kJ, or equivalently a minimum of 925 kJ was generated per mole of potassium. The actual heat generation was clearly higher as the amplifier saturated for about 6 K sec (Figure 21-4). Weight loss was also carefully determined. It was found to be 1.032 gms. Computations of the heat which would be generated by conventional chemistry were made. Only models consistent with the measured weight loss, and the x-ray analyses were considered. As discussed later the most likely set of reactions (Reaction Sequence I) is as follows:



For a sum reaction:

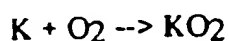


This 'most likely' chemistry indicates that the reduction of the nitrate to the metallic state is an ENDOTHERMIC process. Rather than observing heat evolution, heat should have been absorbed during the reduction process:

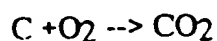
$$(49.32 \text{ Kcal/mol}) * (4.184 \text{ kJ/1 kcal}) * (0.0253 \text{ moles}) = 5.22 \text{ kJ}$$

Thus, there is a difference of more than 28 kJ between the observed process and the heat anticipated on the basis of the 'most likely' chemistry.

Not all of the data fully supported the Reaction Sequence I (RS I) model. First, the weight change was greater than predicted, and second the x-ray work showed that KO₂ (not potassium metal) was present after the reaction was completed and the sample exposed to air. Both findings can be partially explained by the fact that air exposure of fully reduced and well dispersed potassium should lead to a rapid exothermic process in which potassium metal is converted to KO₂ and concomitantly heat is generated. That is, following the formation of potassium metal it is likely two additional reactions (RS II) took place upon air exposure:



$$\Delta H = -68.1 \text{ kcal/mole}$$



$$\Delta H = -94.05 \text{ kcal/mole}$$

If both RS I and II took place the mass loss associated with the net process would be that of one N atom and one O atom for each molecule of KNO₃ initially present. On this basis, and given the fact that 0.0253 mole of nitrate were initially present, the anticipated weight loss is: 0.76 gms. The measured weight change was -1.033 gms. (In fact, the above measure probably slightly overstates the weight loss as some sample is invariably lost during the two transfer processes between measurements: transfer to the calorimeter at the beginning, and transfer from the calorimeter at the end.) On this basis it is postulated that 0.273 gms were lost via the formation of carbon dioxide. The process of carbon dioxide formation that would use up 0.273 gms of carbon would yield a heat of 8.95 kJ.

In order to explain observed heats it is always reasonable to postulate chemistry different from the 'most likely' scenario (RS I). For example, if RS I and II both took place in the cell prior to air exposure (potassium oxide and carbon dioxide being the final products) a total of 10.94 kJ of heat would be generated. This is considerably less than that observed experimentally (23.4 kJ),

but not enough less that one could comfortably claim anomalous heat production. Moreover, this proposed sequence (I + II) is consistent with the x-ray data, as well as with the observed weight loss.

Other reaction processes are also consistent with the x-ray data. It appears that these other reactions ALL yield heats LESS THAN that for RS I plus RS II.. For example:



This reaction only yields 0.83 kJ for the number of moles of nitrate initially present. If this reaction occurred and carbon dioxide formation in the cell accounted for the remaining mass loss than a total of 9.78 kJ would be observed. Again, the computed total heat evolution is within a factor of 3 of that measured experimentally.

Given the composition of the catalyst, it is clear the greatest heat generation per gram would occur via the direct combustion of carbon. Indeed, if all the weight loss were associated with CO₂ formation the heat evolved would be 33.04 kJ for a weight loss of 1.03 gms. This would clearly account for all the observed heat, as well as the weight change. It is not consistent with the x-ray results, or gas phase chemical analysis reported by HCP.

As shown in the x-ray results the sample prior to treatment consists primarily of carbon and potassium nitrate. The 'Before' results do indicate the limitations of X-ray analysis. For example, even lines from palladium, an element known to be present, cannot be found. Still, the comment that carbon and potassium nitrate are the predominant species initially present is undoubtedly correct (21-8, 21-9, 21-10). It is also clear that following the deactivation of the catalyst and is subsequent exposure to air the predominant potassium phase is KO₂.

In sum, the above analysis indicates that additional data must be collected which limits the number of reasonable reaction sequences. The gas phase analysis conducted by HCP for example, tends to support the 'most likely' scenario above. That is, the discovery of NH₃ and no reports of

CO or CO₂ support this analysis. The discovery of some NO supports the suggestion that the process may even be more endothermic than that suggested by the 'most likely' scenario.

In the next couple of experiments efforts were made to eliminate CO₂ formation during air exposure, and to insure that the heat released during the reaction of oxygen with reduced metal was determined calorimetrically.

SAMPLE 113095A - The sample contains 8.3276 gms of total material, and was nominally 37 percent by weight potassium nitrate (3.08 gms or 0.0305 moles KNO₃). Grafoil loaded potassium made up 97% of the material, and the remaining 3% of the material was carbon supported palladium.

After the initial touch test (Fig. 22-1) the calorimeter temperature was raised to 125 C and held at that temperature in flowing helium for about 12 hours at which time it was determined the baseline was reasonably stable (Fig. 22-2). Hydrogen was introduced into the cell and almost immediately a moderate sized heat peak, generally considered to result from the formation of hydride, was observed (Fig. 22-3). About two hours after the 'hydride peak' reached its apex the signal began to rise significantly (Fig. 22-3). In fact, after about six hours the signal reached a value equivalent to the production of about 0.50 watts. Given a net input flow rate of 2.1 ml/min, and assuming a perfect stoichiometry of 2 hydrogen molecules per oxygen molecule, water formation would yield 0.24 watts. Assuming that all of the oxygen was 'free' and already present in the sample chamber (air leaks flowing inward against two atmosphere of hydrogen pressure assumed to be minimal), this flow rate of hydrogen completely converted to water would yield 0.35 watts. (In fact, there is no reason to believe there is any 'free' oxygen in the system. Any oxygen associated with a potassium oxide would yield scant heat upon potassium reduction and hydrogen oxidation. Reduction of carbon oxides would in fact be endothermic in most cases.) On the basis of the first calculation, it can be seen (22-4,5,6) that the rate of heat production exceeded that anticipated from the formation of water for 66 ksec (more than 18 hours). The catalyst clearly deactivated over the next 20 ksec (Figs. 22-6,7) until no heat at all was being produced. During

the period of heat production a total of more than 31 kJ of energy was evolved, or equivalently more than 1016 kJ/mole potassium initially present.

According to the model proposed by Phillips in earlier reports, the state of the fully deactivated catalyst should be metallic potassium. This suggestion was tested by exposing the deactivated sample to dry air (20% oxygen) slowly (approx. $20 \text{ cm}^3/\text{min}$). A slow exposure to oxygen should prevent the type of rapid heating which conceivably can lead very high heating and concomitantly a limited amount of combustion of the carbon support. Unfortunately, due to a communication breakdown, no attempt was made to measure the amount of heat evolved.

A final measure of the weight loss of a sample which was handled in a fashion designed to eliminate post-deactivation combustion was quite revealing. The sample was found to lose 0.856 gms of weight. A net loss of one nitrogen and one oxygen per mole of nitrate initially present would lead to a weight loss of 0.915 gms. This suggests 'good' agreement between the model of potassium nitrate decomposition (RS I) and then potassium oxide (KO_2) formation during air exposure as outlined in the discussion of the previous sample above. According to that model at most 2.4 kJ could have been generated. This assumes there is no carbon dioxide formation. Indeed, given the weight loss there is no reason to believe carbon dioxide was formed.

If a worse case scenario is assumed, and all weight loss is attributed to the formation of carbon dioxide, we find that 28 kJ of total heat would be generated. This is close to the total amount of heat actually observed. Clearly it is important to unambiguously demonstrate that carbon monoxide and carbon dioxide are not generated to any extent during the 'reduction' cycle.

A 'best case' scenario may also be envisaged. Imagine that the decomposition process only produced potassium metal, oxygen and nitrogen (see first line in RSI). How many electron volts would be produced per atom of potassium initially present? That is, we assume that the 31 kJ observed is the net AFTER the heat required for the endothermic decomposition process is subtracted. This scenario requires that a total of 46 kJ were generated in an 'anomalous' fashion in order to account for the observed 31 kJ. Given the number of moles of

potassium initially present, this is equivalent to the generation of 15.7 eV/atom of potassium initially present.

Finally, it must be noted that analysis of this sample is not complete. X-ray study of the post treatment state of the potassium has not yet been carried out. The assumption that KO_2 is the final state of the potassium has not yet been demonstrated. As discussed with reference to sample 120495A (below), this is not always the case.

SAMPLE 120495A - The sample contains 8.82 gms of total material, and was nominally 37 percent by weight potassium nitrate (3.26 gms or 0.0323 moles KNO_3). Grafoil loaded potassium made up 97% of the material, and the remaining 3% of the material was carbon supported palladium.

After the initial touch test (Fig. 23-1) the calorimeter temperature was raised to 125 C and held at that temperature in flowing helium for about 12 hours at which time it was determined the baseline was reasonably stable (Fig. 23-2). Hydrogen was introduced into the cell and almost immediately a moderate sized heat peak, generally considered to result from the formation of hydride, was observed ((Fig. 23-3). About four hours after the 'hydride peak' reached its apex the signal began to rise significantly (Fig. 23-4). In fact, after about seven hours the signal reached a value equivalent to the production of about 0.50 watts. Given a net input flow rate of 3.3 ml/min, and assuming a perfect stoichiometry of 2 hydrogen molecules per oxygen molecule, water formation would yield 0.37 watts. Assuming that all of the oxygen was 'free' and already present in the sample chamber, this flow rate of hydrogen completely converted to water would yield 0.55 watts. (In fact, as explained with reference to sample 113095a there is no reason to believe there is any 'free' oxygen in the system.) On the basis of the first calculation, it can be seen (23-4,5,6) that the rate of heat production exceeded that anticipated from the formation of water for 55 ksec (more than 15 hours). The catalyst clearly deactivated over the next 40 ksec (Figs. 23-6,7) until no heat at all was being produced. During the period of heat production a total of more than 33 kJ of energy was evolved.

According to the model proposed by Phillips in earlier reports, the state of the fully deactivated catalyst should be metallic potassium. This suggestion was tested by exposing the deactivated sample to dry air (20% oxygen) slowly. The air was mixed with helium to insure the rate of heat evolution during the oxidation process could be measured. Also, a slow exposure to oxygen should prevent the type of rapid heating which conceivably can lead very high heating and concomitantly a limited amount of combustion of the carbon support. The composition of the oxygen containing mix was nominally that shown on Figure 23-8; however, there is reason to believe that the mix ratio was not precisely controlled. In any event, it is clear that heat did evolve upon the slow exposure of the sample to an oxygen containing mix for several days (Fig. 23-9 through 23-17). The total heat evolved during this period of time was about 10.5 kJ.

X-ray studies revealed that the primary product of the slow oxidation process was potassium hydroxide. There was evidence that KO_2 was present in limited amounts. In previous studies conducted in this laboratory the Grafoil supported deactivated samples were found to be primarily KO_2 with some KO_3 present. The reason that KOH formed in the present case probably relates to difference in the rate of oxidation. In previous studies oxygen exposure was rapid, probably leading to great increases in temperature, which probably favored more complete oxidation.

Weight loss can be used as a check on the x-ray analysis. The weight 'loss' anticipated for the net conversion of 0.0323 moles of KNO_3 to KOH is 1.45 gms. The observed weight loss was 1.20 gms. In contrast if 50% of the potassium nitrate converted to KOH and 50 % to KO_2 the expected weight loss would be 1.21 gms. This suggests that the later estimate is more reasonable. In any event, there is no reason to believe that any weight loss should be attributed to carbon combustion.

Given x-ray analysis showing KOH as the final product rather than KO_2 , an effort to convert KOH to KO_2 was undertaken. The sample was heated in air for four hours at 200°C . This caused the sample to gain weight, such that the NET weight loss was 1.02 gms (and not 1.20 gms). Given the number of moles initially present, the predicted weight loss for complete

conversion of KNO_3 to KO_2 is 0.97 gms. The measured weight loss is consistent with this model. X-ray studies to determine the final state of potassium are planned.

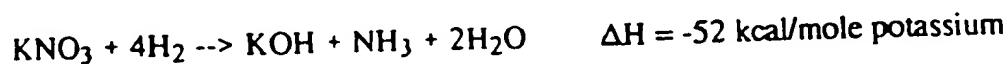
Given the assumption that potassium metal was present at the start of the oxidation process and the final composition of the potassium is a 50/50 mixture of KOH and KO_2 the heat evolved should be 11.3 kJ. This compares very well with the actual heat evolved of 10.5 kJ.

An alternative hypothesis is suggested by the x-ray revelation that the final state of the potassium was KOH (Figs 23 18-26). This suggests that a model must account for the presence of hydrogen in the final structure. One explanation is that the potassium state prior to oxygen exposure was KH and not K-metal . This would increase the expected heat to some extent. That is, we assume the following reactions take place in parallel during oxygen exposure:

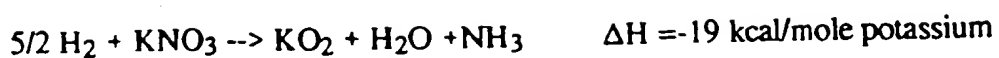


Next, we assume the same final disposition of the potassium (accounts for measured weight change) was a 1/1 mix of oxide and hydroxide. This would lead to the generation of 11.5 kJ. This is almost the same as that computed for the system assuming the final state of potassium was metallic.

It's revealing to compare the total heat evolved with the total heat anticipated simply from conventional chemistry. The conversion of 0.0323 moles of KNO_3 per the reaction below:



yields only 7 kJ for the amount of potassium originally present. Other scenarios yield even less heat. For example, if all the potassium were converted to oxide:



less heat would be produced. In fact only 2.6 kJ would be produced via this route. Thus, the MAXIMUM heat that can be accounted for by conventional routes for potassium nitrate conversion is 7 kJ. Other factors, for example the need to account for weight change, suggest even less heat should have been observed.

Even this maximum value for heat production from conventional chemistry is more than a factor of six less heat than observed experimentally. The observed experimental heat, greater than 43 kJ, is the sum of that released during hydrogen flow (>33kJ) and that measured during oxygen flow (>10kJ). In fact, the predicted heat is less than that observed during the oxidation process alone.

Finally, it is worth considering a worse case scenario. How much heat would be released if all the weight loss were due to carbon combustion? Given the weight loss of 1.02 gms, equivalent to less than 0.1 moles of carbon, we find 34 kJ would have been evolved to form CO₂. This value is uncomfortably close to the value actually measured. Yet this scenario is extremely unlikely. Indeed, where would 'free' oxygen come from during the hydrogen flow process? Why would it react to form carbon dioxide and not water? Moreover, carbon doesn't combust well at only 125 C. How do we explain the clear change in the crystal structure of the potassium without concomitant weight loss associated with that process?

SUMMARY/RECOMMENDATIONS

It is now clear that heat can be produced repeatedly from mixtures of potassium nitrate loaded carbon and noble metal carbon samples provided by HCP. It is also clear that there is a regular pattern: hydrogen flow leads to heat production, initially at a very high rate, but gradually decaying to yield a 'deactivated' catalyst. This deactivated catalyst releases additional heat during subsequent exposure to oxygen. Moreover, a final x-ray analysis indicates the crystal structure of

the potassium changes from a nitrate to an oxide during the process. Weight change can be attributed to changes in potassium crystal structure alone, if oxygen is admitted slowly.

It is also clear that there are many conventional chemical scenarios which lead from the initial nitrate structure to the final oxide structure. None of these can account for the observed heats.

It is clear that the model of potassium transformation accompanied by anomalous heat needs to be strengthened before this model is submitted to the scientific community. Specifically, three recommendations for further study are made. First, it is recommended that tests to confirm directly the postulated change in the potassium from nitrate to metal in flowing hydrogen be undertaken. If it can be verified that heat is released during a process which converts potassium nitrate to potassium metal, then the claim that anomalous heat has been observed is greatly strengthened. The change from nitrate to metal is ENDOTHERMIC. The best method for carrying out the proposed work is to employ *in situ* x-ray analysis.

Second, it is recommended that the heat release and crystal structure transformations of potassium nitrate on carbon in the absence of any noble metal be studied. In the absence of hydrogen atoms it is postulated that the same decomposition of the nitrate will take place. However, there should be no anomalous heat production. In fact, the overall transformation of the nitrate to a metallic state in flowing hydrogen at elevated temperature should be endothermic. Following the complete decomposition of the nitrate oxygen exposure should lead to significant heat release. The behavior of these samples should also be studied using both calorimetry and *in situ* x-ray diffraction.

One change in procedure is urged. Every effort should be made to study the composition of the off-gas during anomalous heat production. A clear certification that carbon oxides are not detected strengthens the argument that weight changes are related to changes in the structure of the potassium nitrate and not to the combustion of the support material.



Fig. 21-1
Touch Test (111395a)

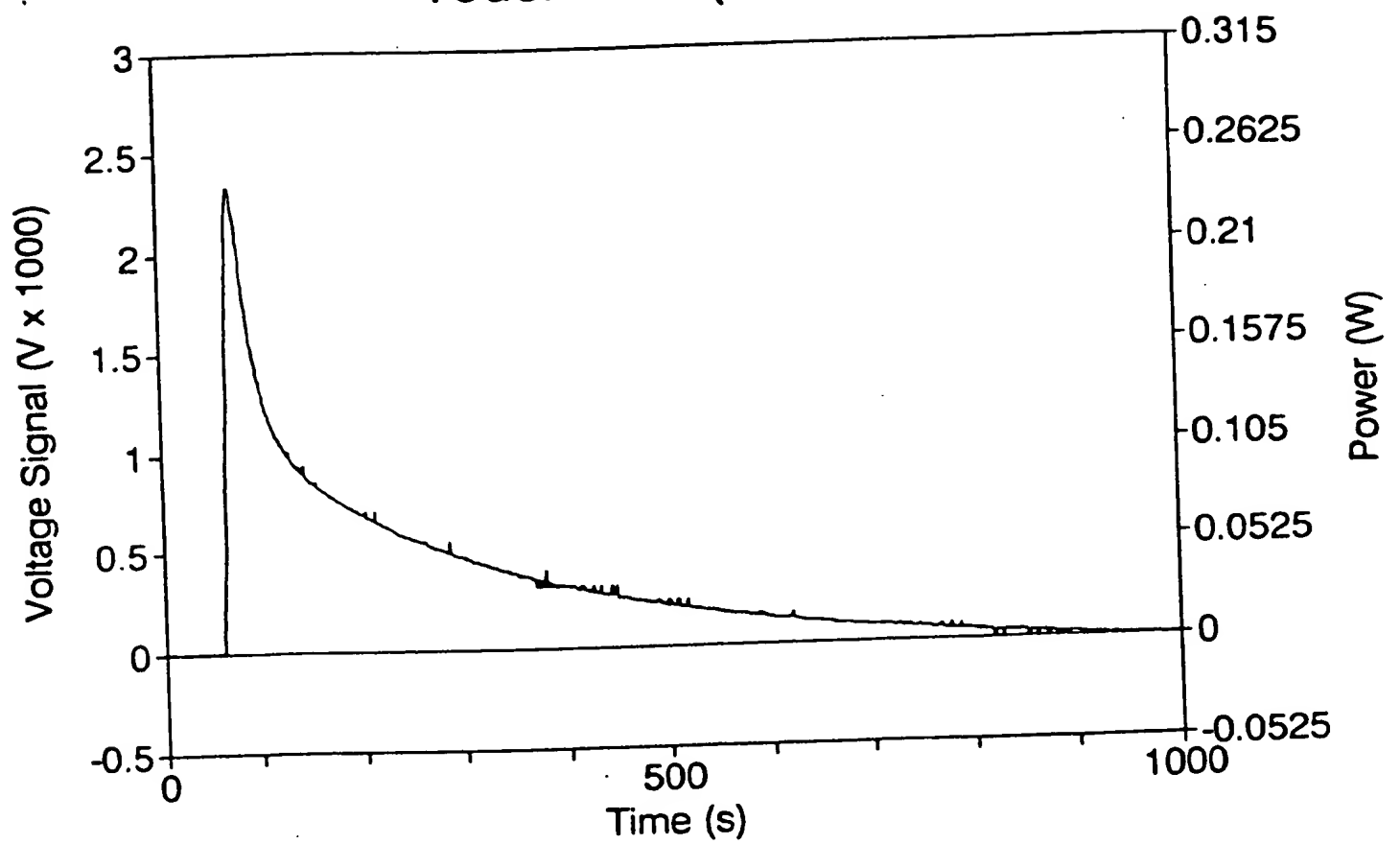


Fig. 21-2
Base Line 1 at 200 C (111395a)

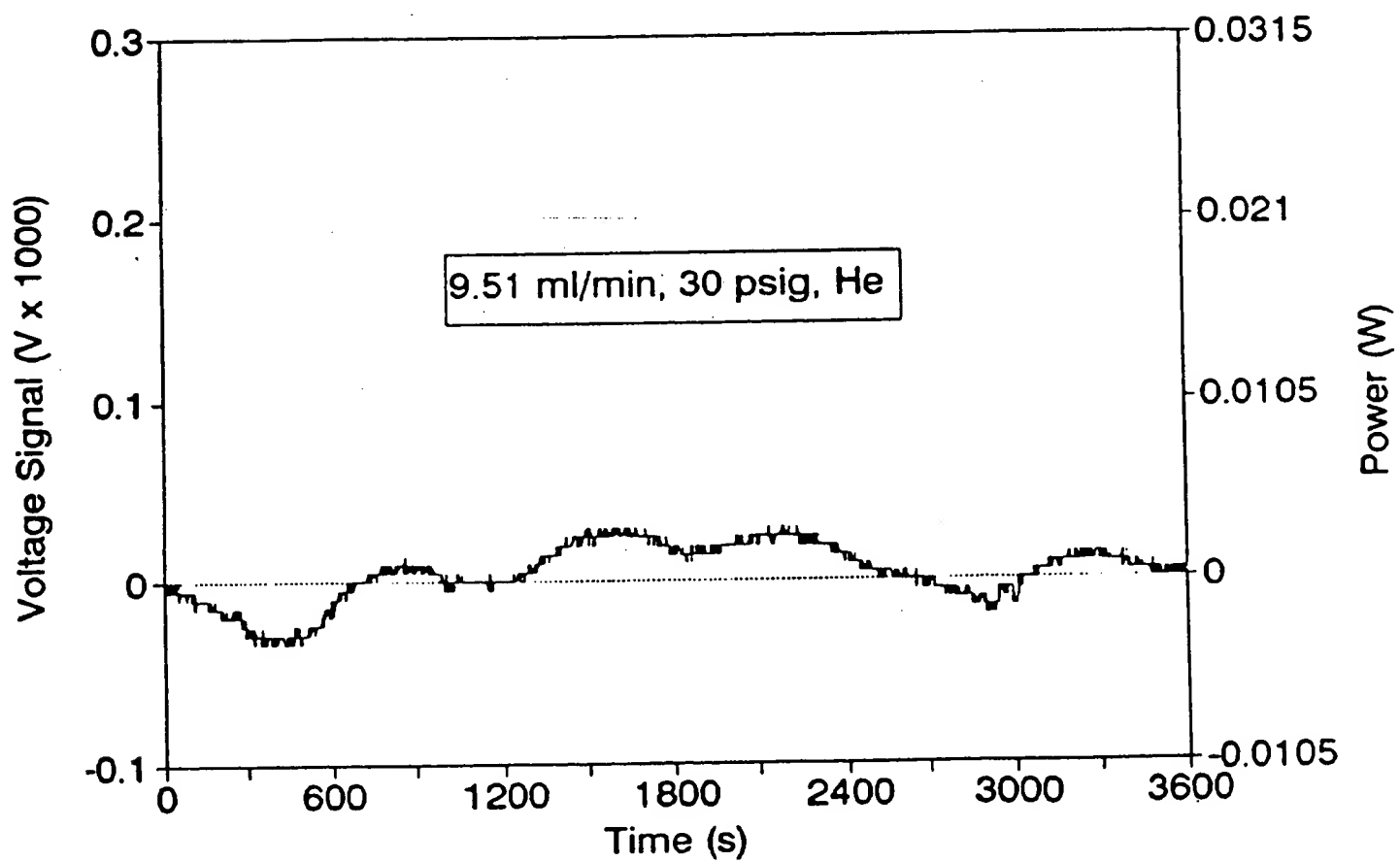


Fig. 21-3
Switch from He to H₂ at 200 C (111395a)

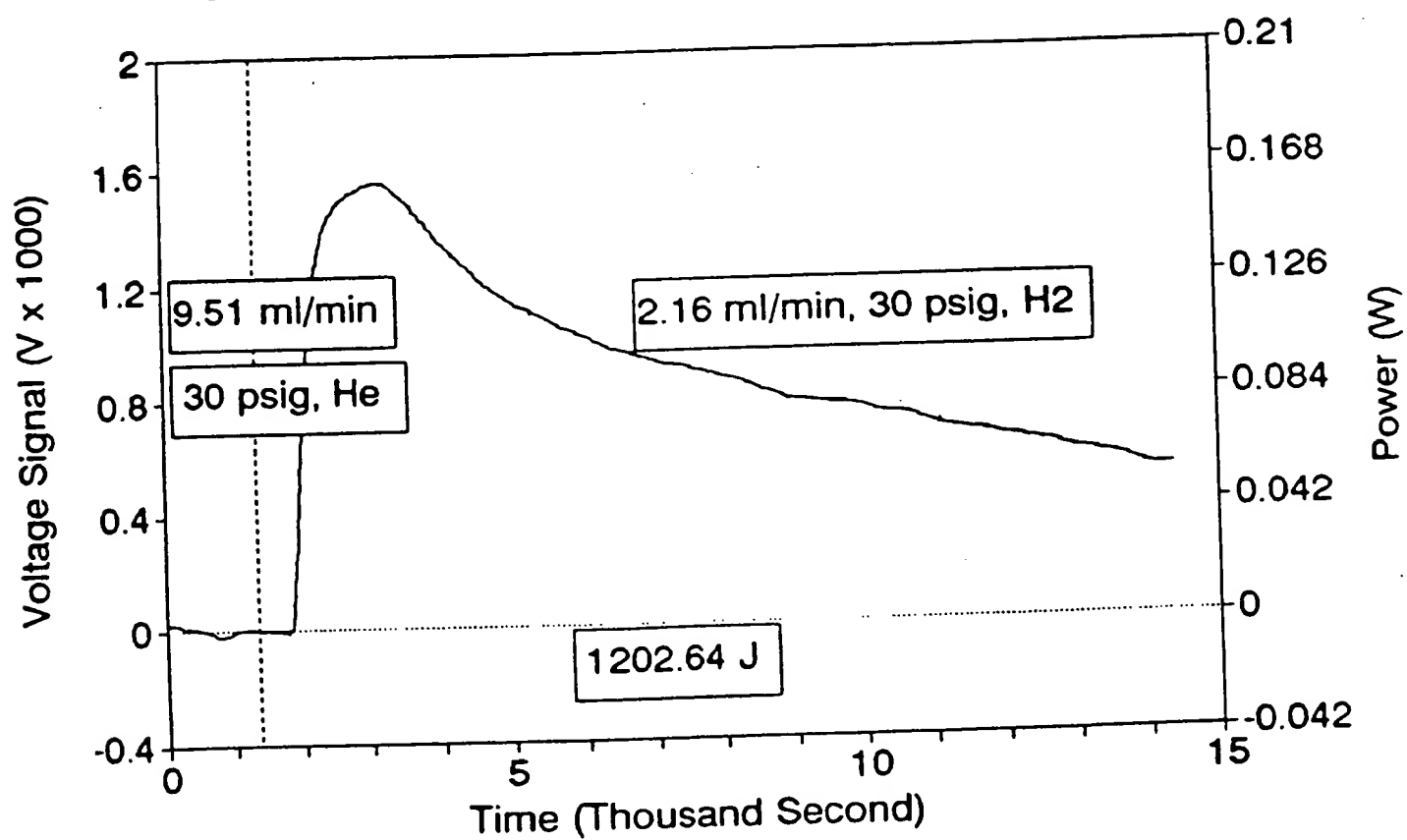


Fig. 21-4
H2 reaction 1 at 200 C (111395a)

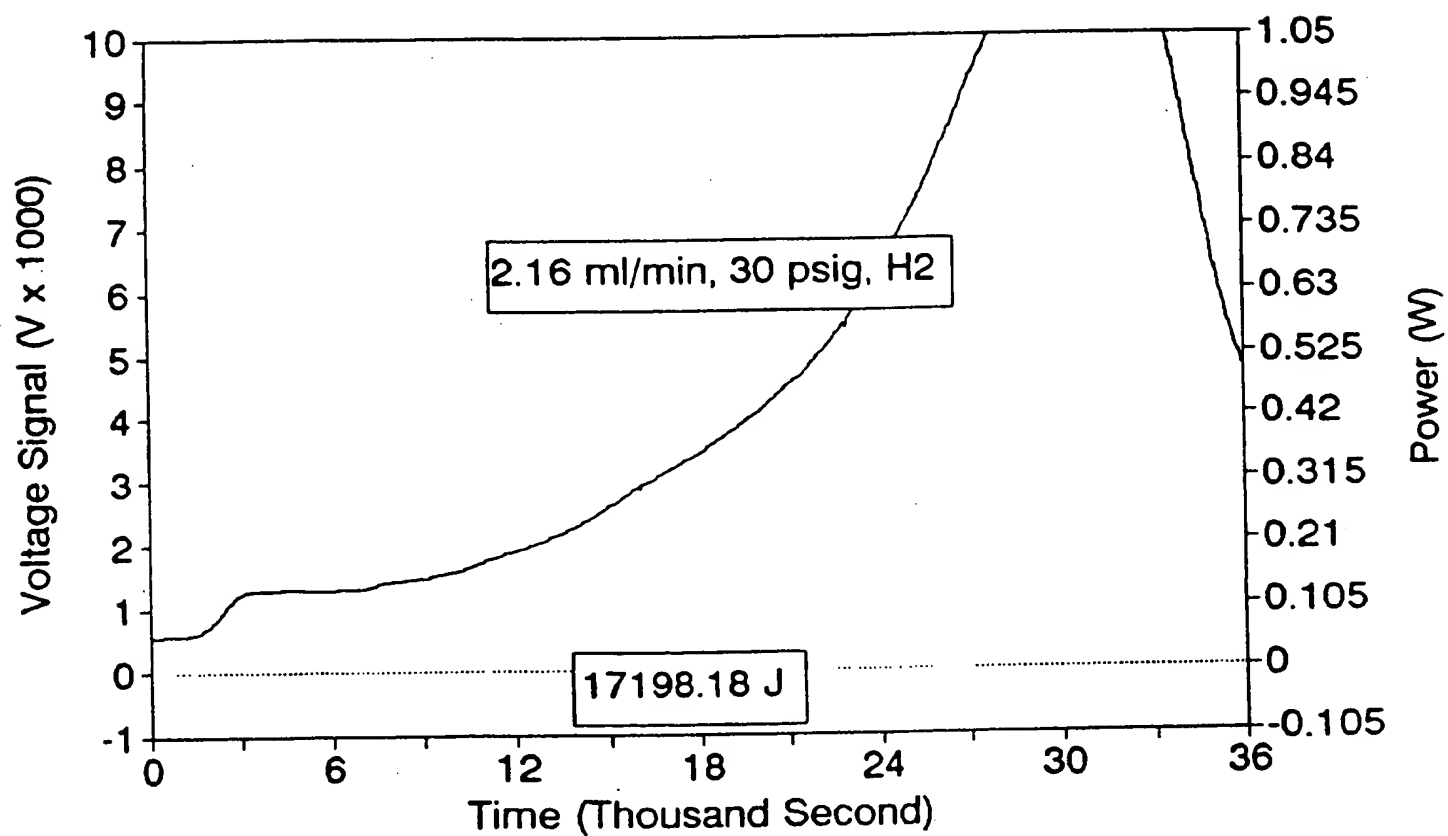


Fig. 21-5
H2 reaction 2 at 200 C (111395a)

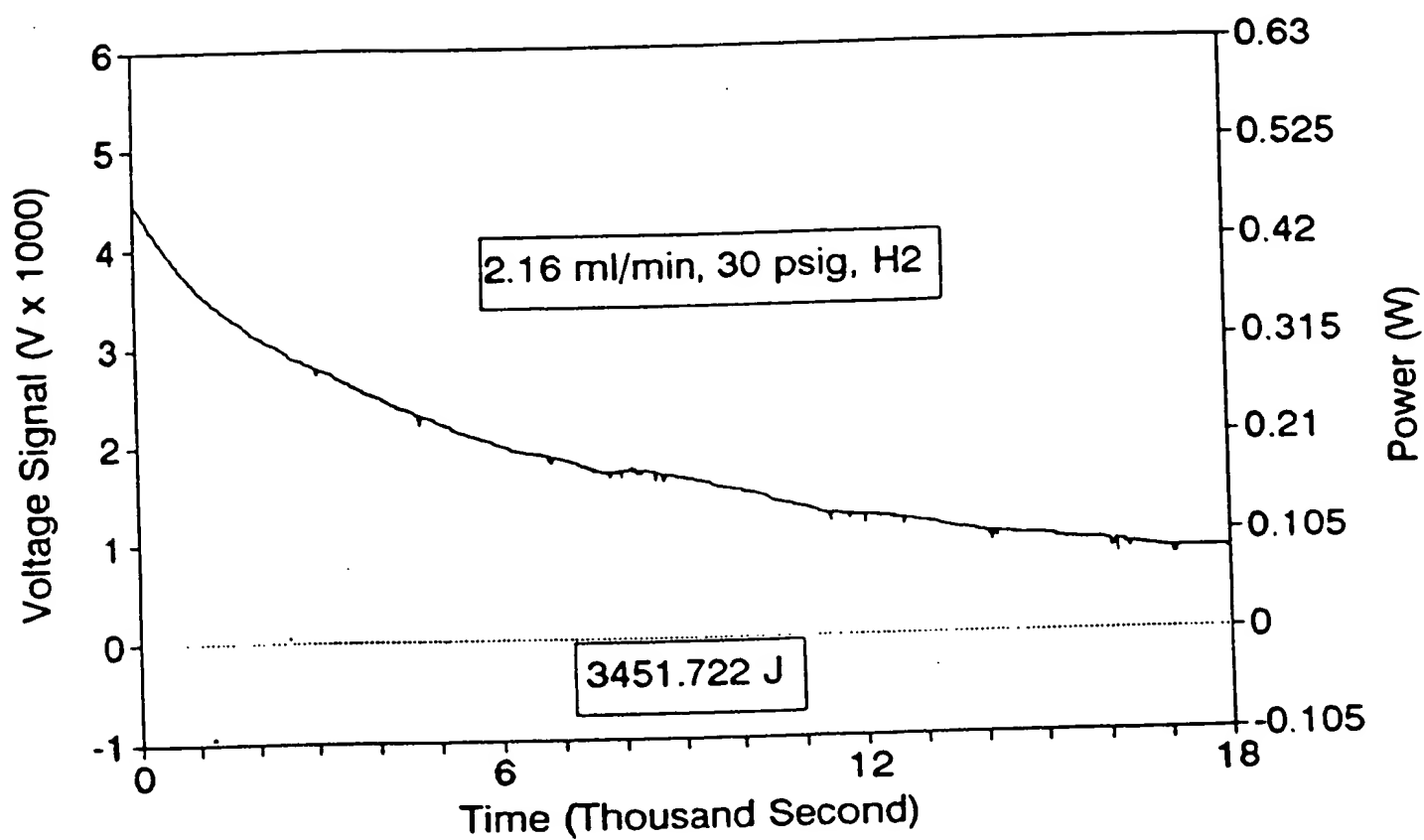


Fig. 21-6
H₂ reaction 3 at 200 C (111395a)

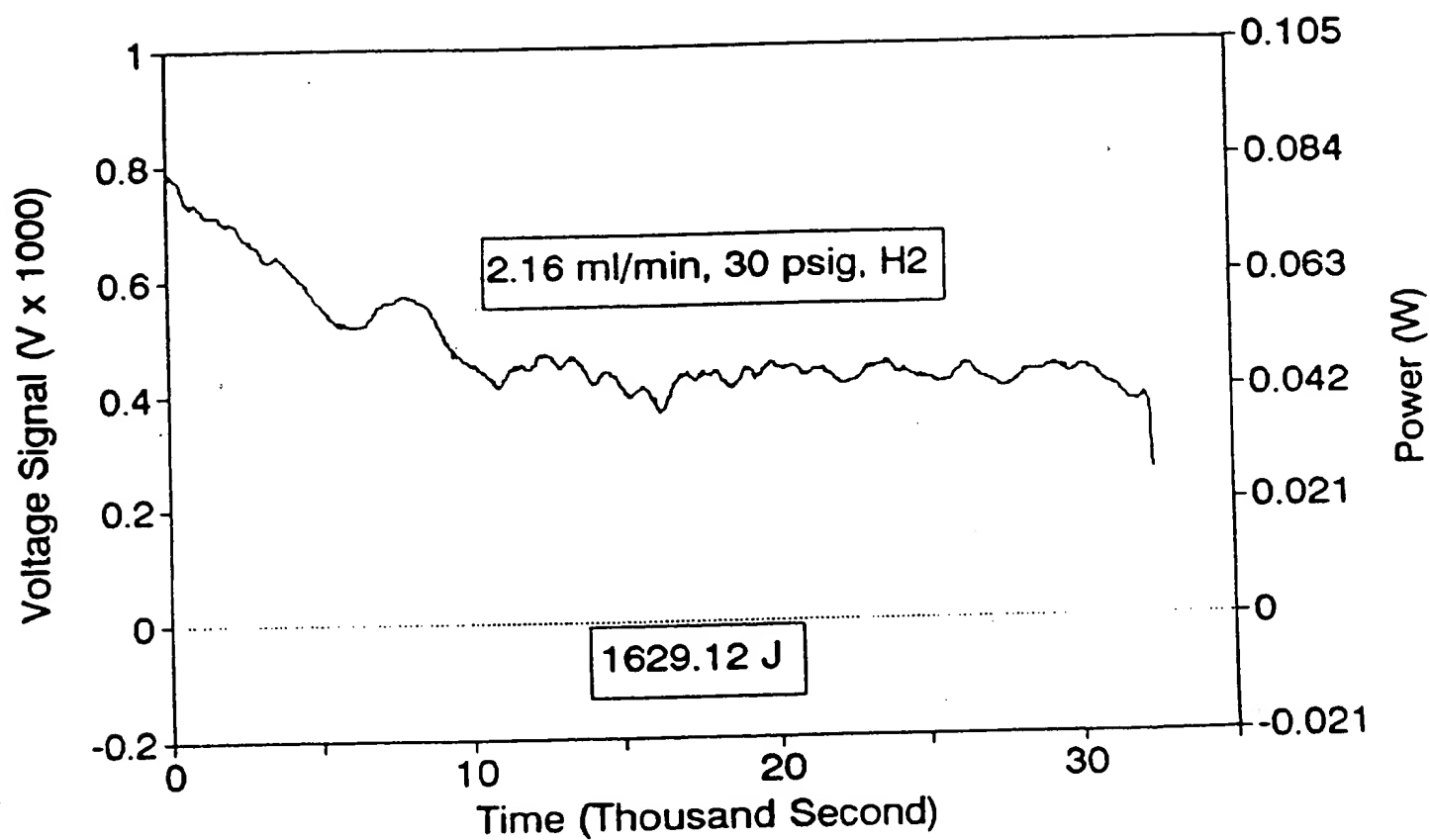
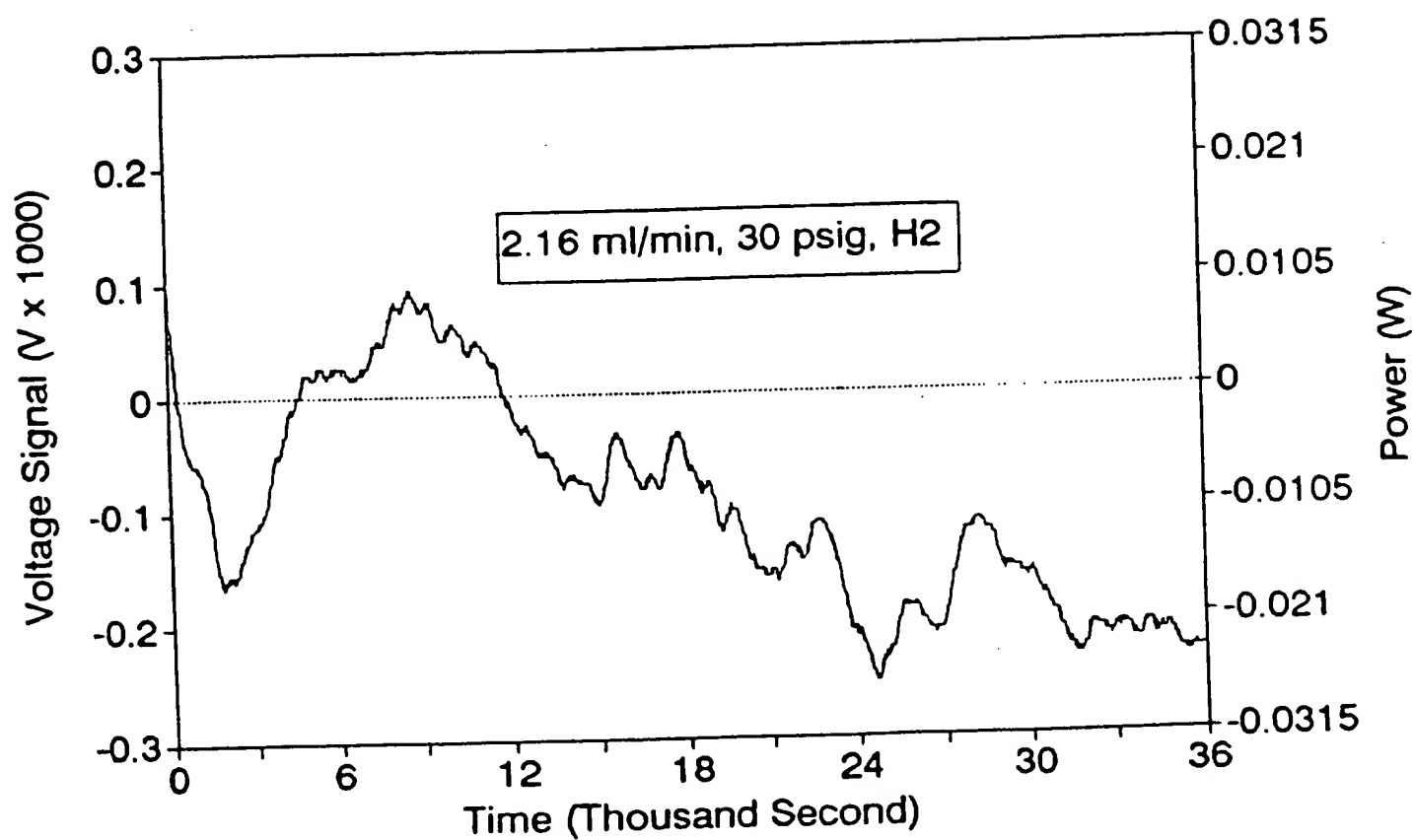
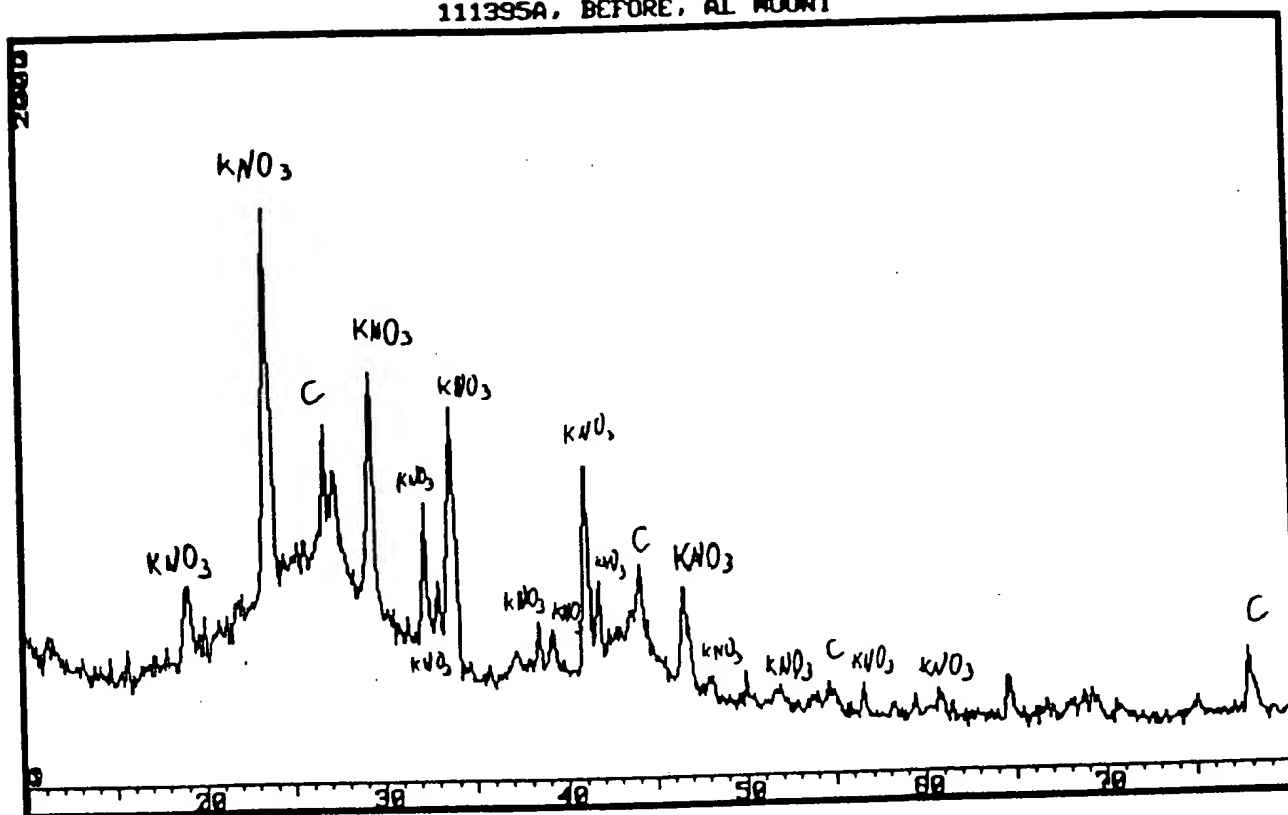


Fig. 21-7
H₂ reaction 4 at 200 C (111395a)



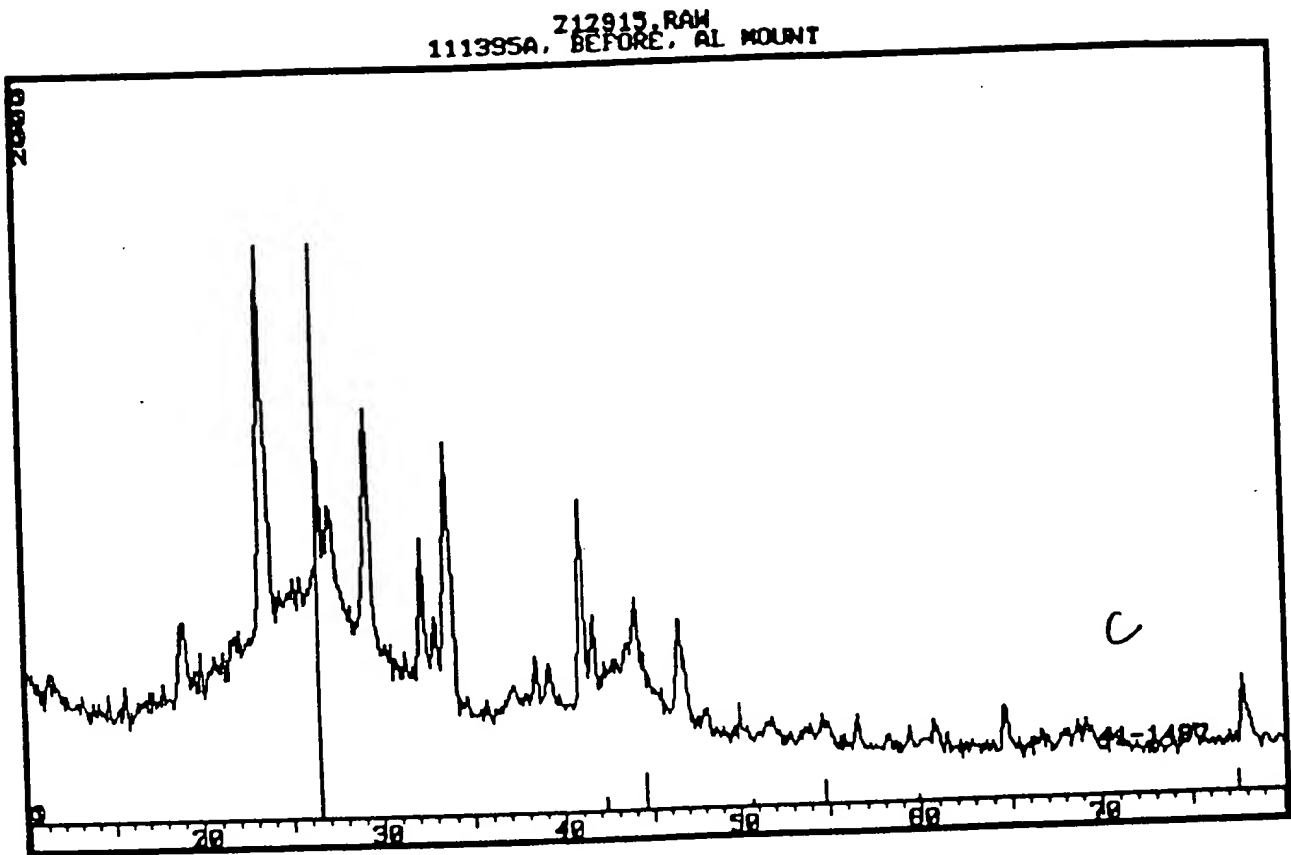
111395 A , Before

212915.RAW
111395A, BEFORE, AL MOUNT

11/28

21-9

111 395 A, Before



11/28

21-10

Z12915.RAW
111395A, BEFORE, AL MOUNT

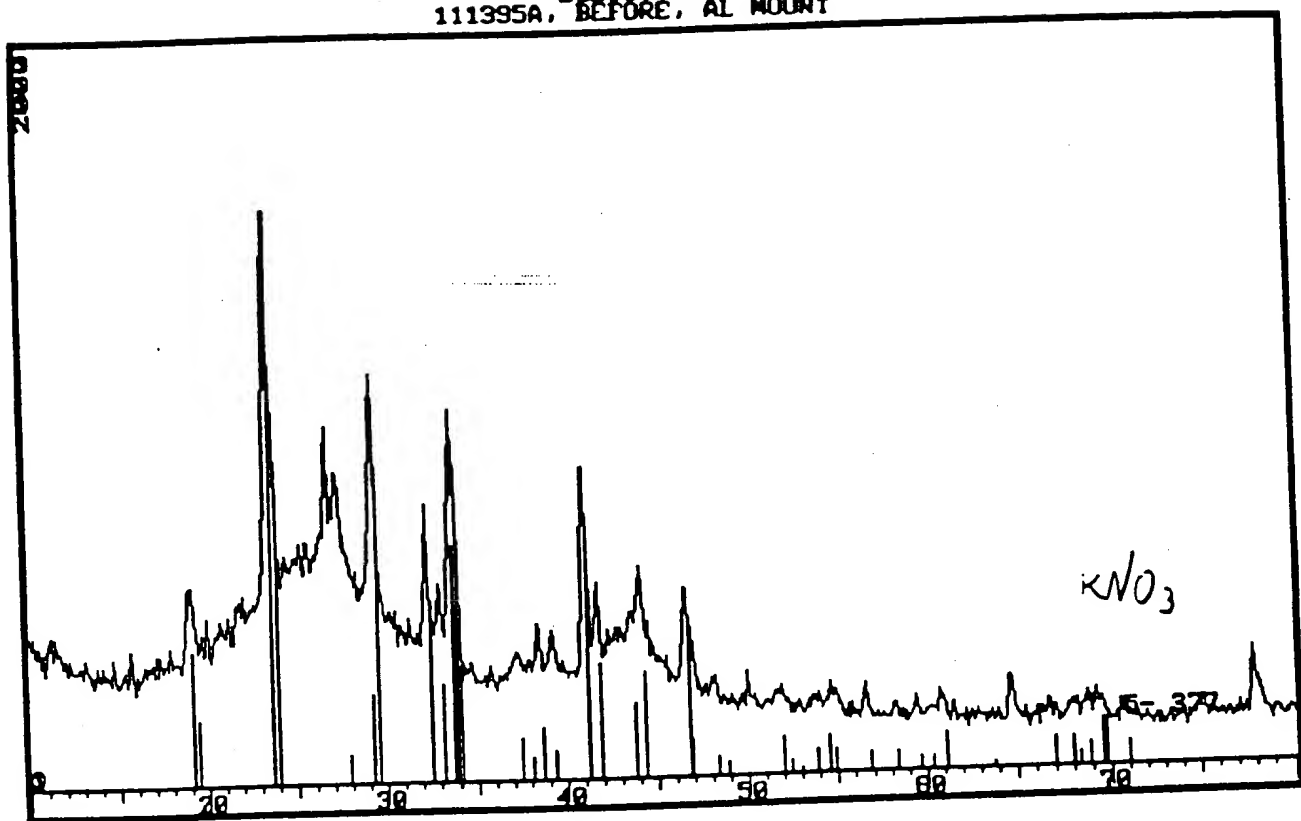


Fig. 22-1
Touch Test (113095a)

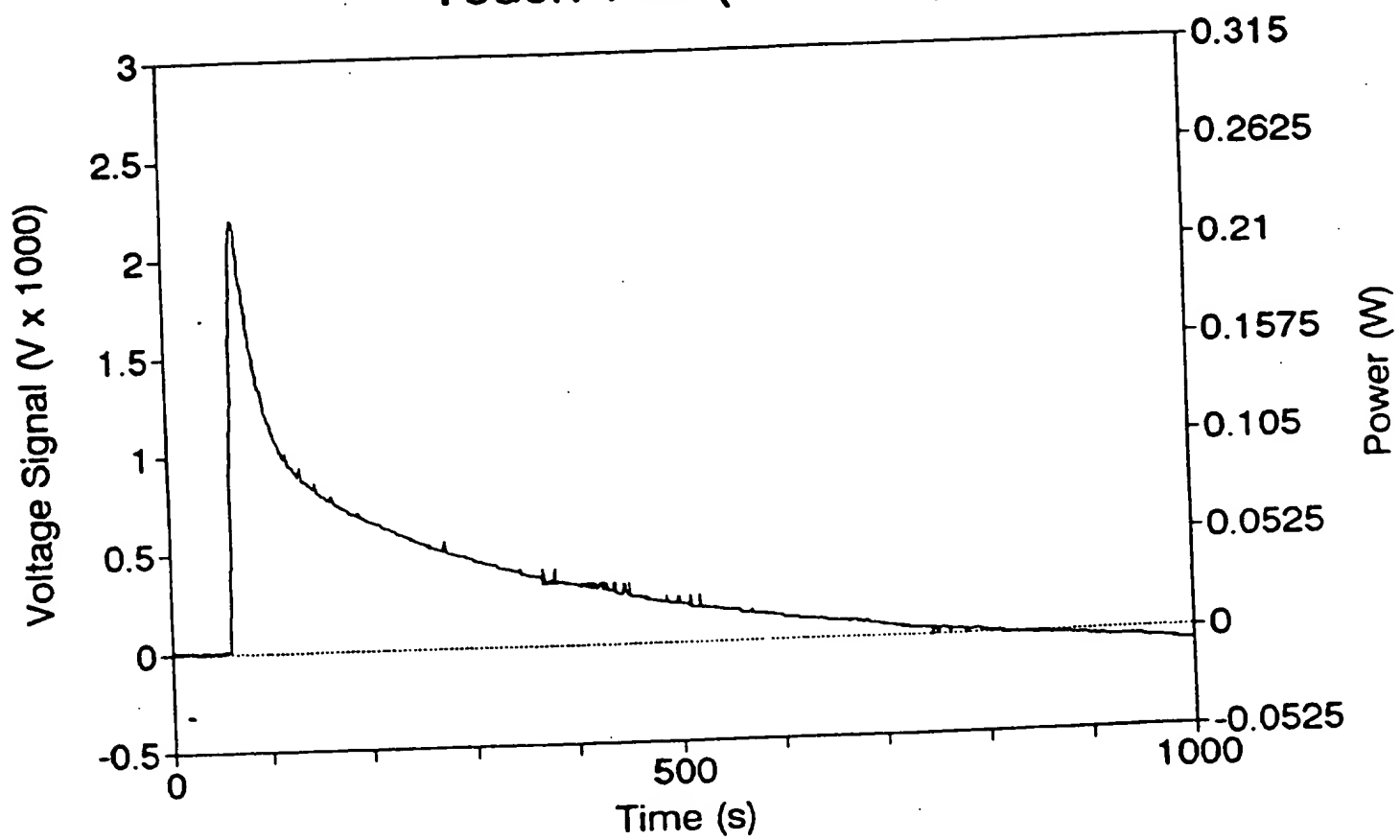


Fig. 22-2
Base Line 1 at 125 C (113095a)

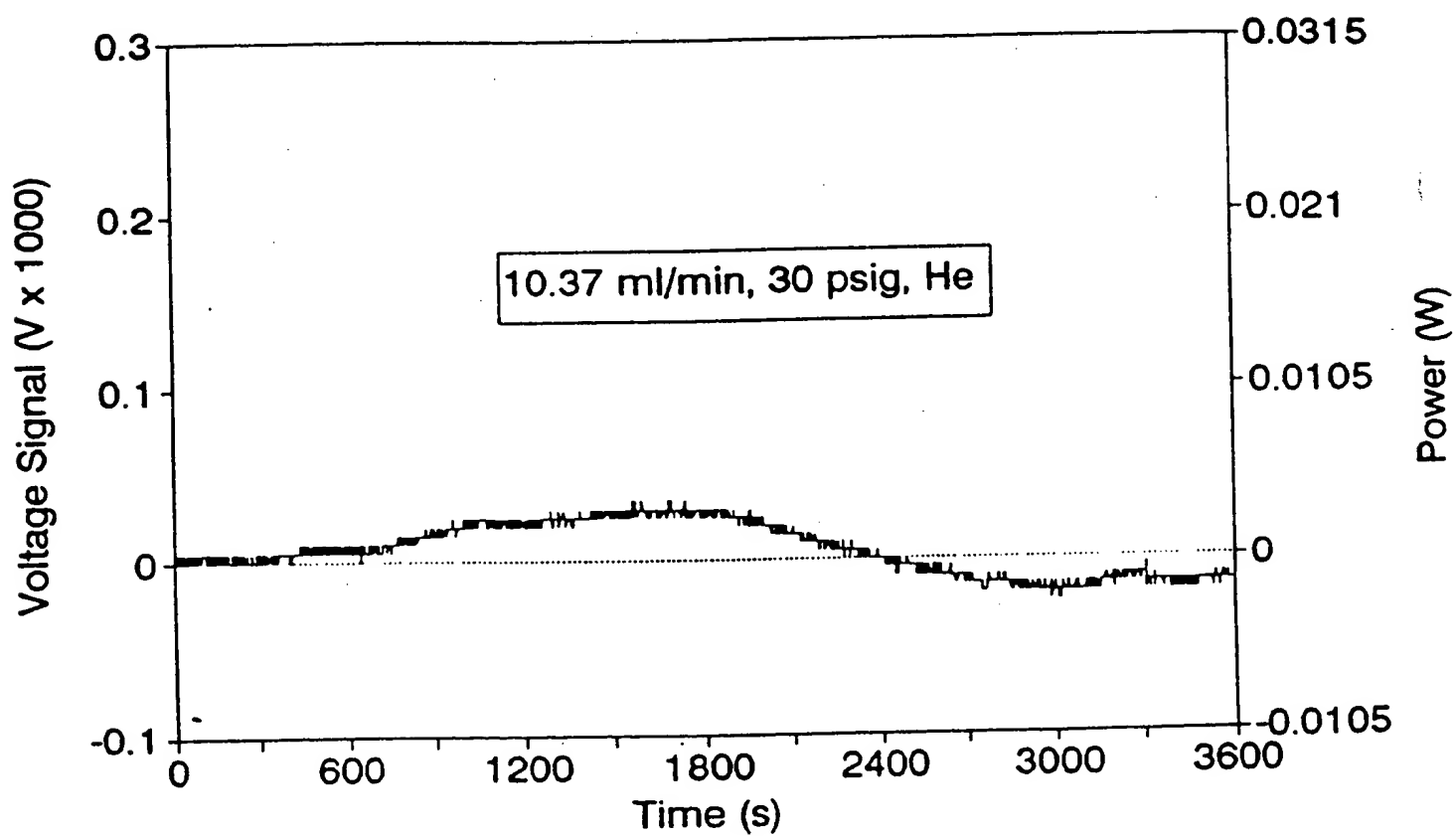


Fig. 22-3
Switch from He to H₂ at 125 C (113095a)

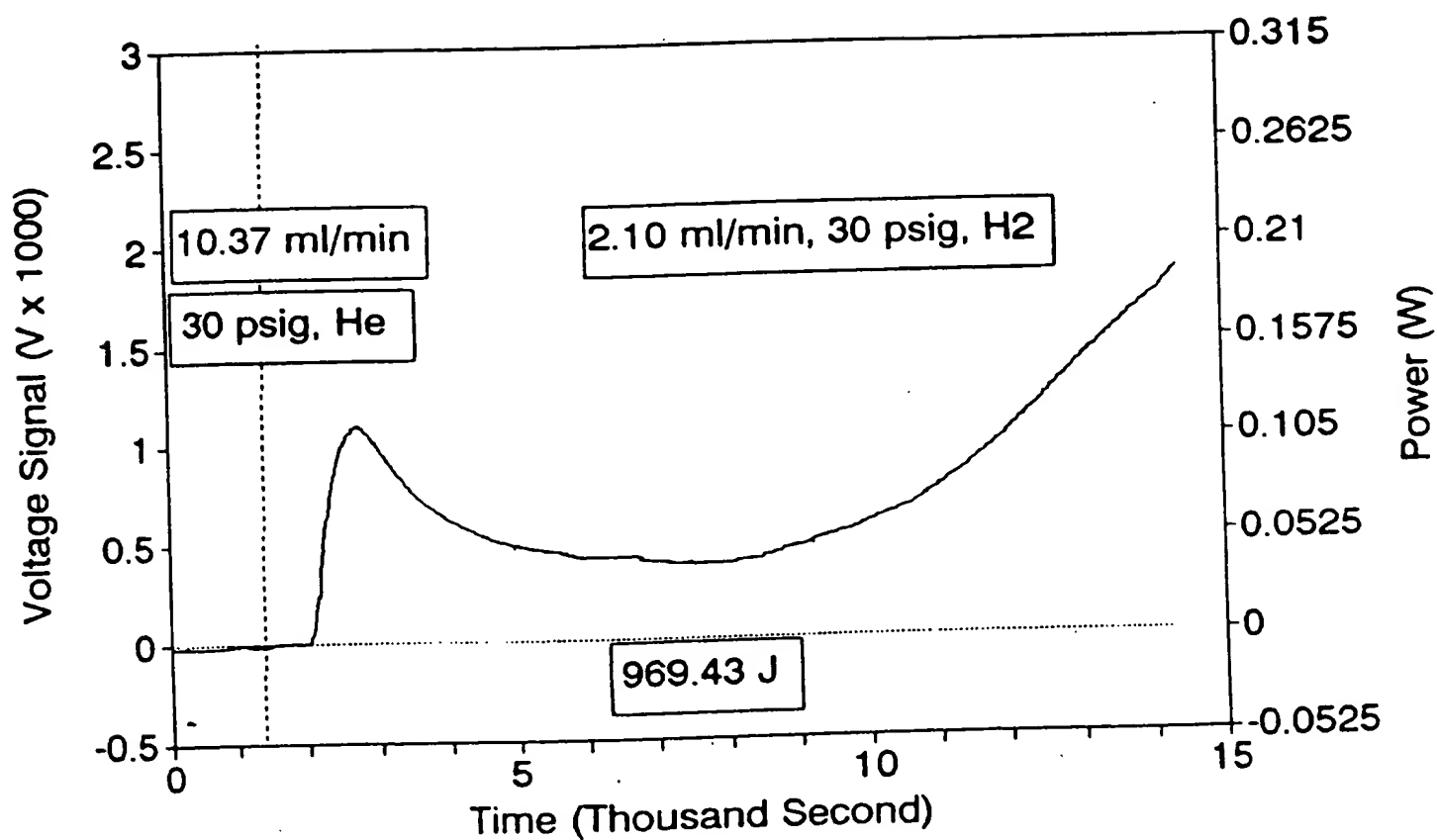


Fig. 22-4
H2 reaction 1 at 125 C (113095a)

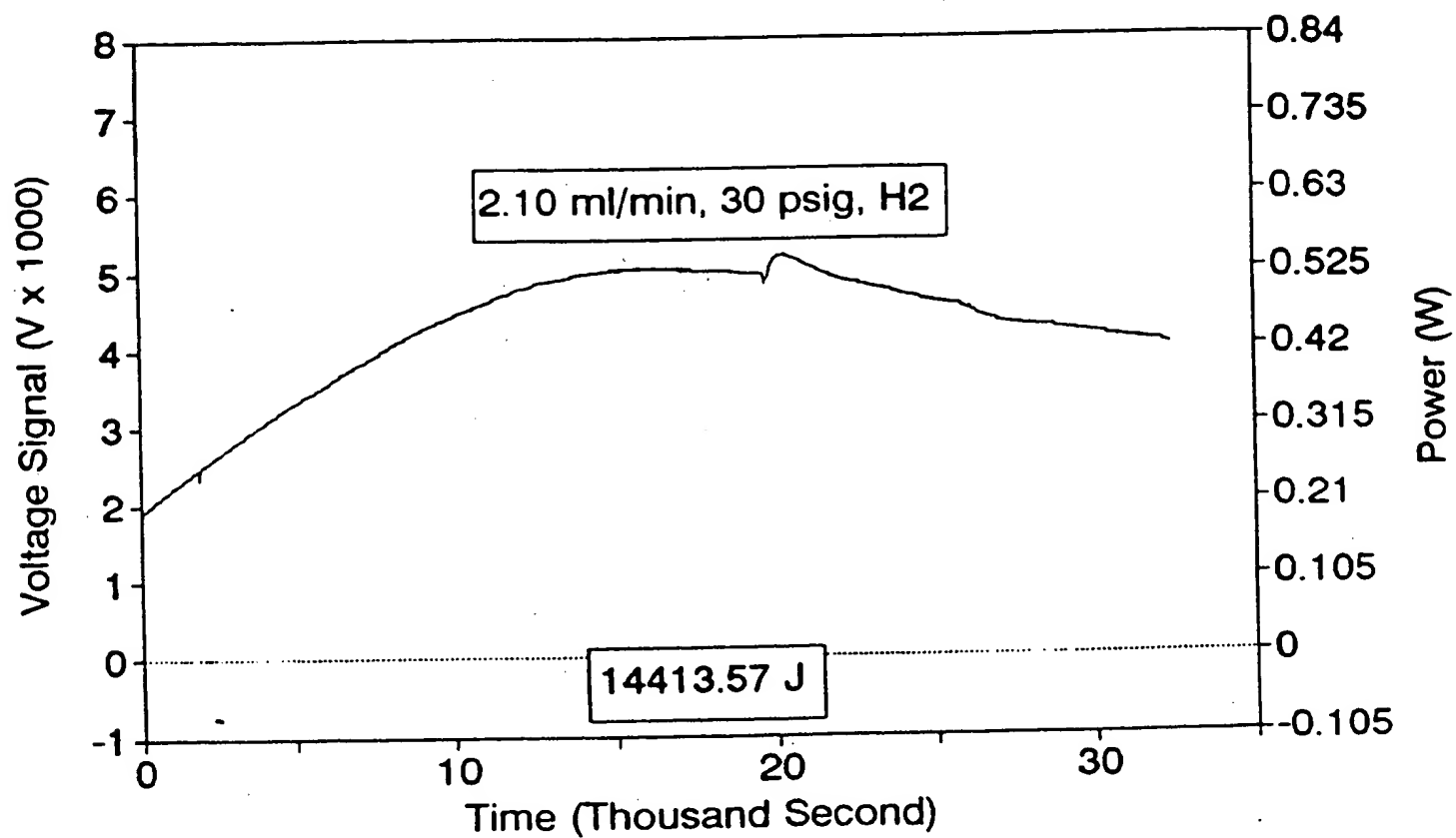


Fig. 22-5
H2 reaction 2 at 125 C (113095a)

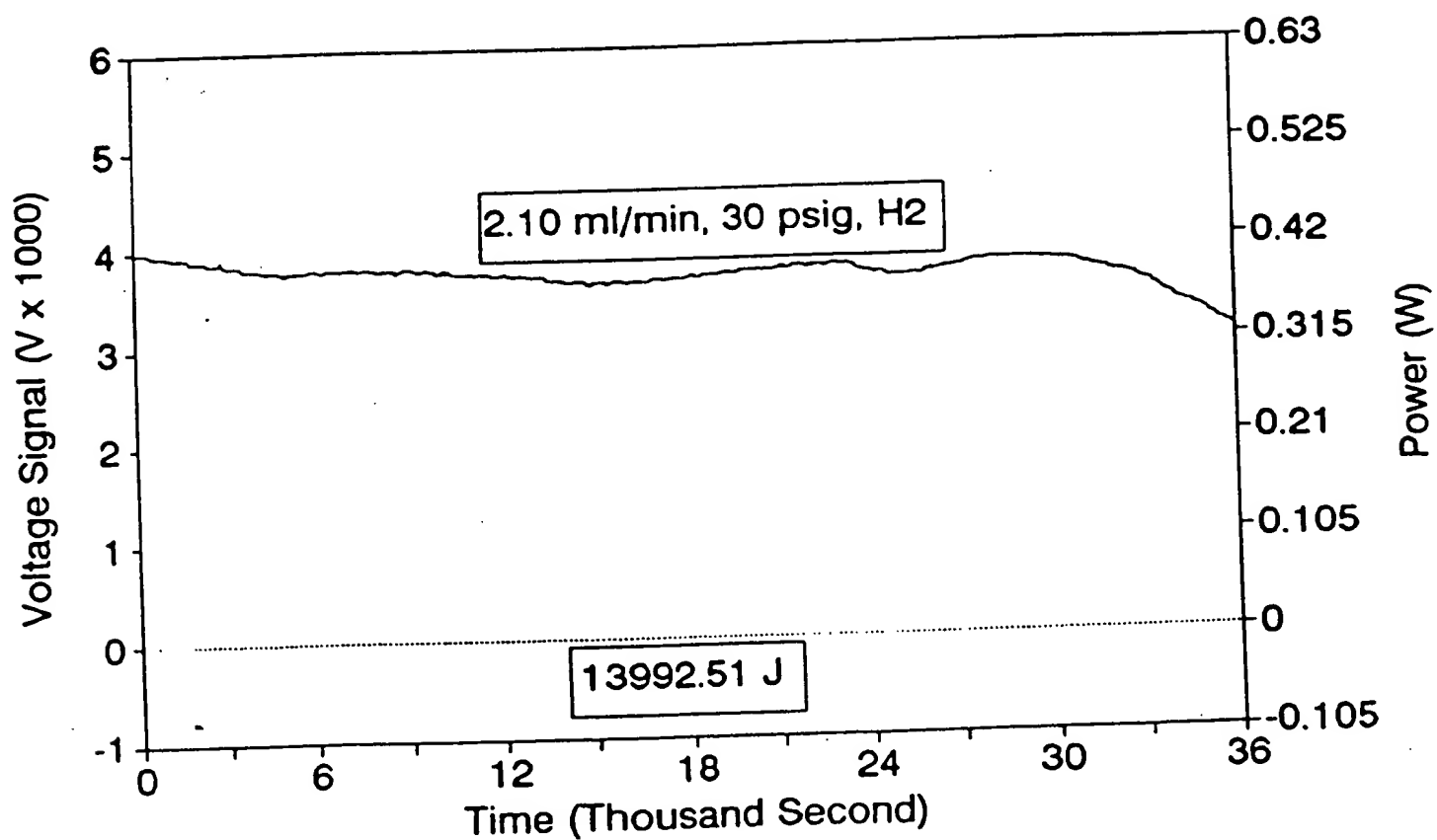


Fig. 22-6
H₂ reaction 3 at 125 C (113095a)

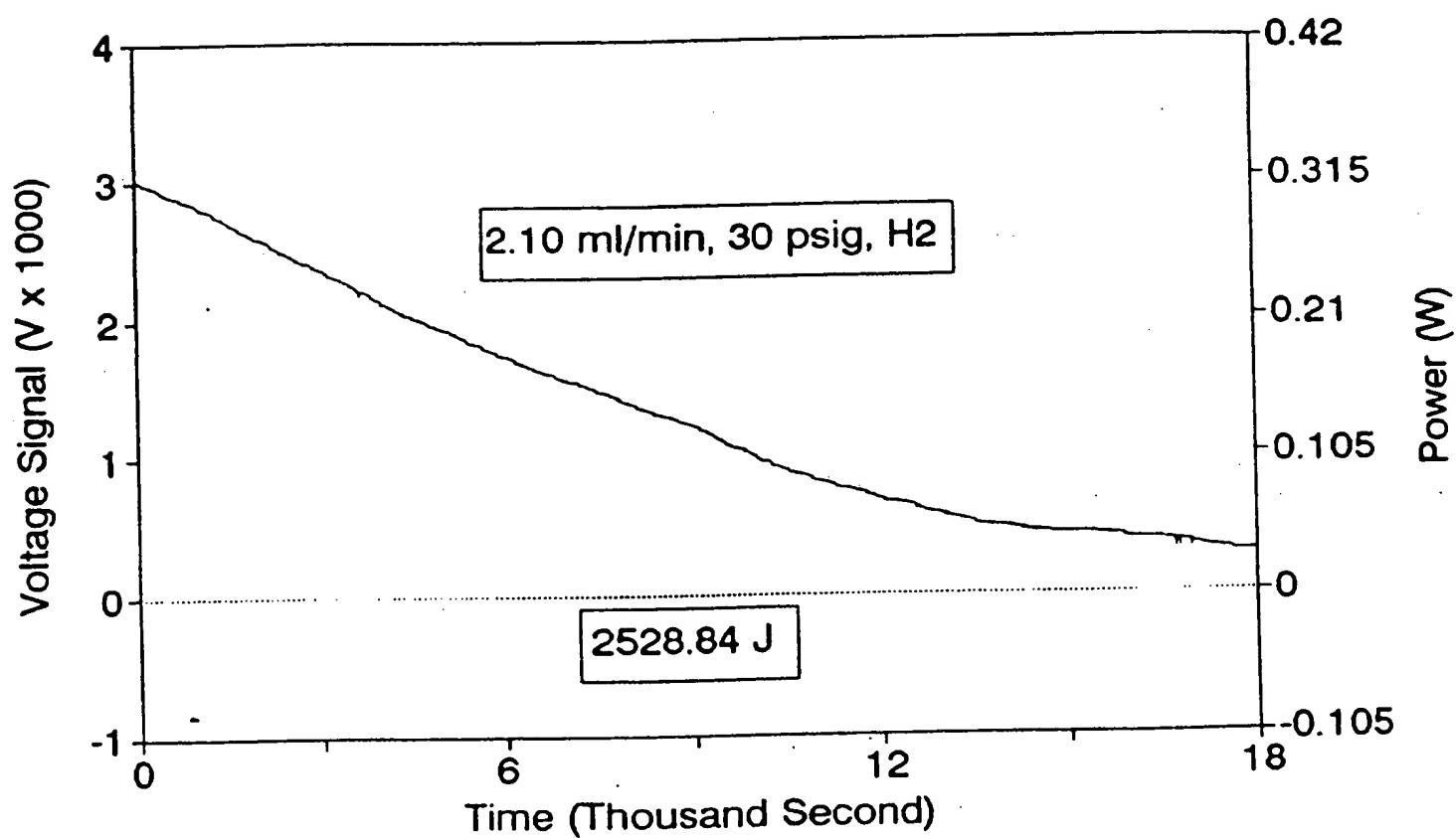


Fig. 22-7
H₂ reaction 4 at 125 C (113095a)

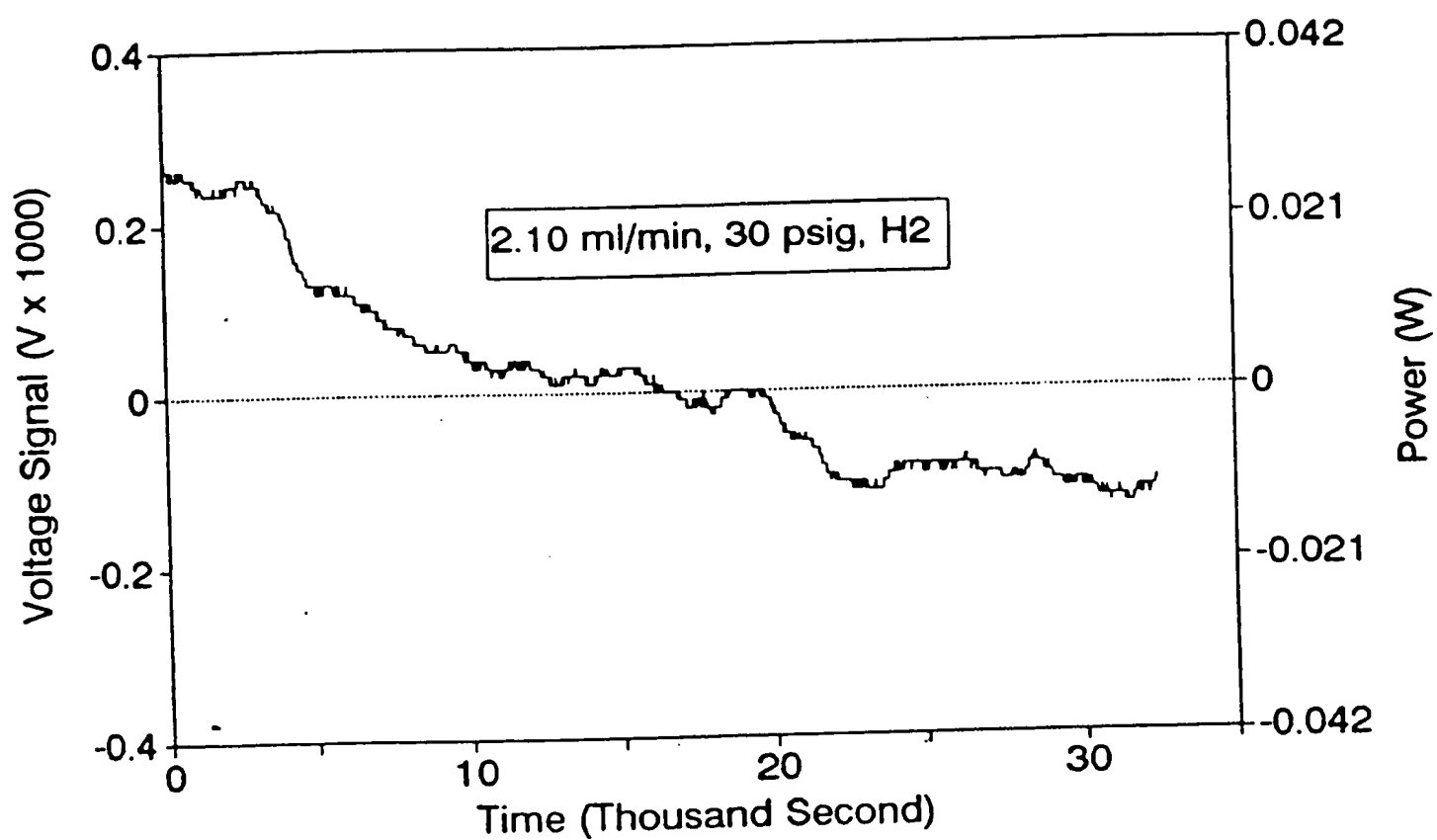


Fig. 23-1
Touch Test (120495a)

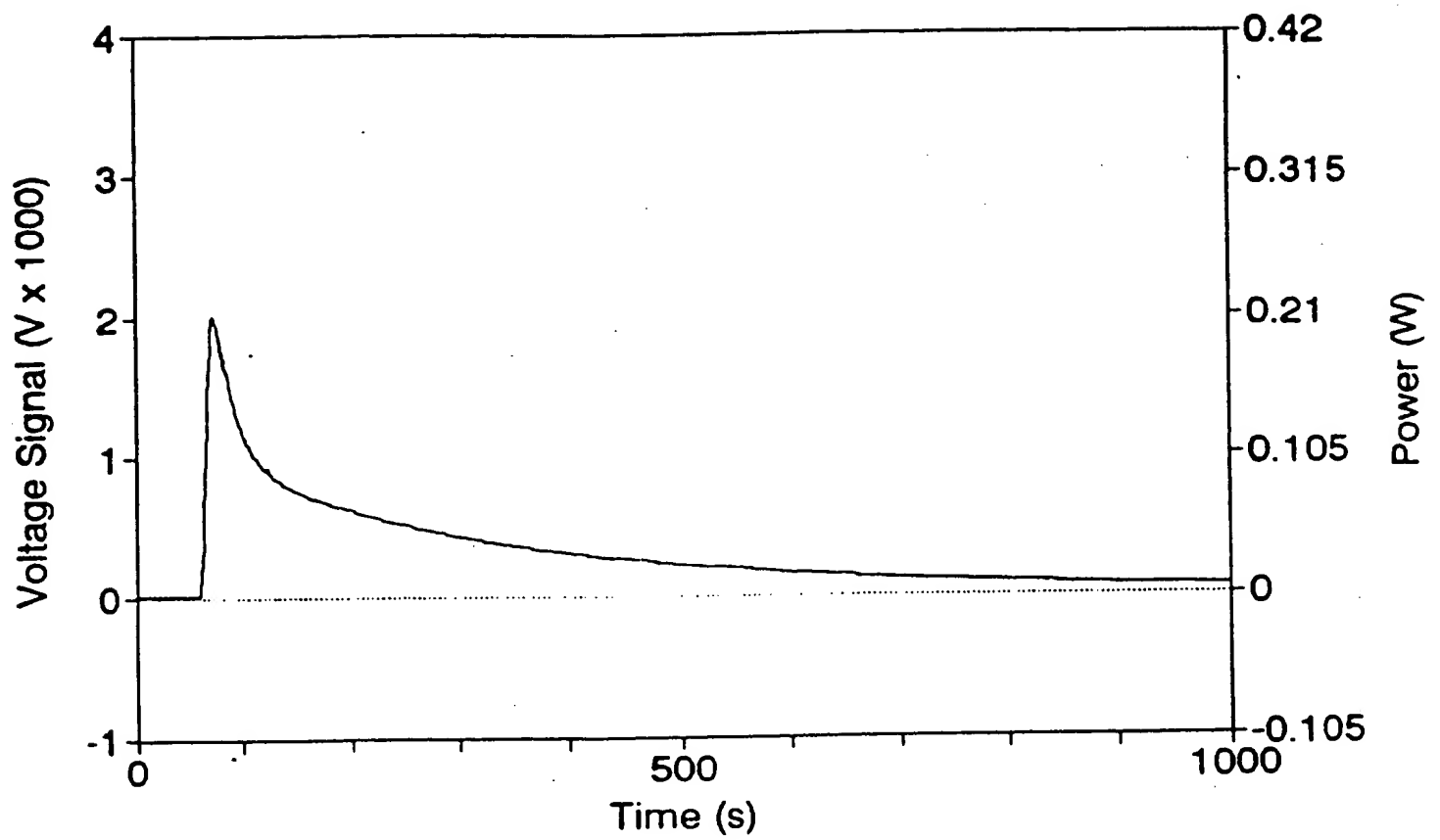


Fig. 23-2
Base Line 1 at 125 C (120495a)

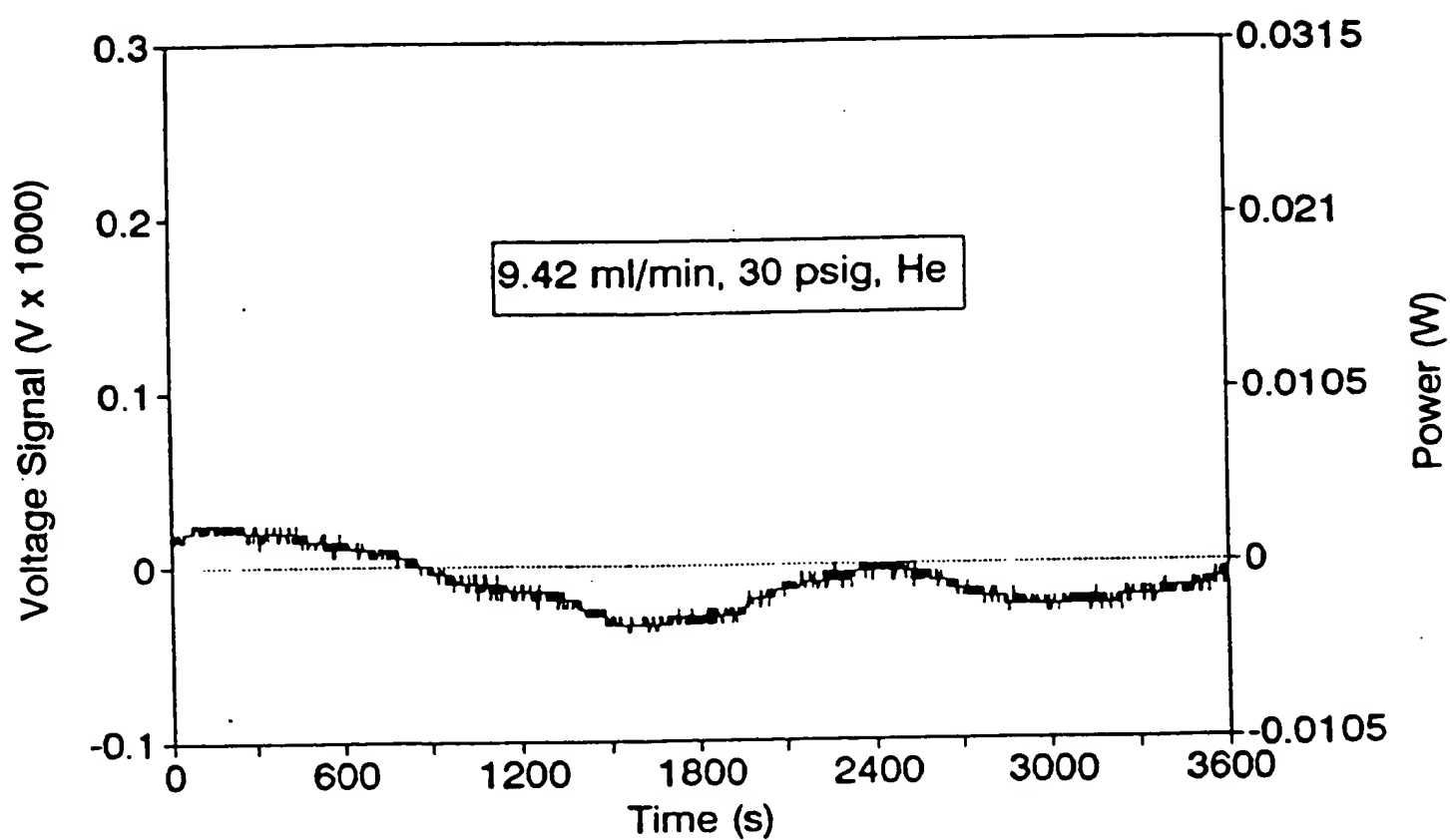


Fig. 23-3
Switch from He to H₂ at 125C (120495a)

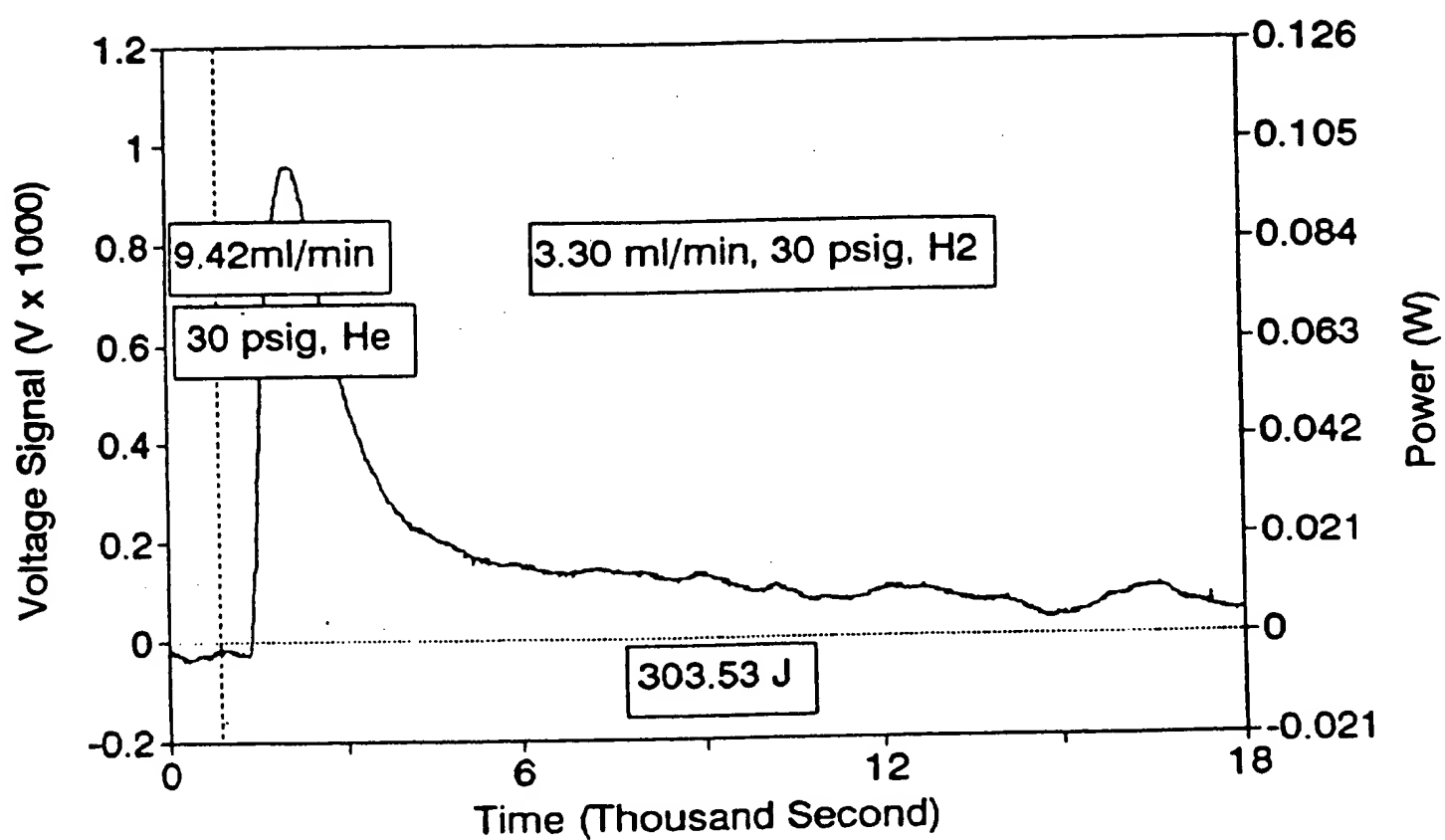


Fig. 23-4
H₂ reaction 1 at 125 C (120495a)

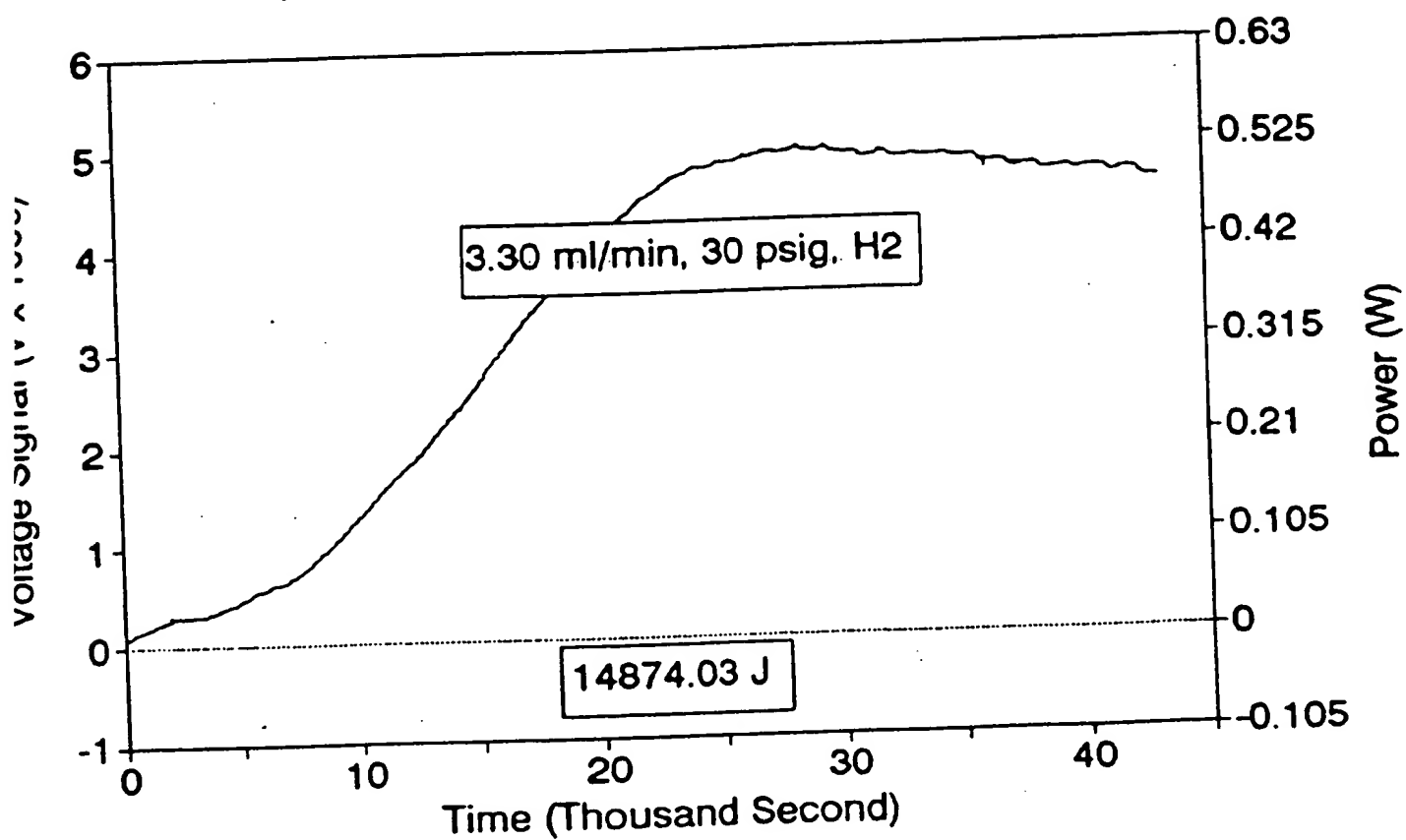


Fig. 23-5
H2 reaction 2 at 125 C (120495a)

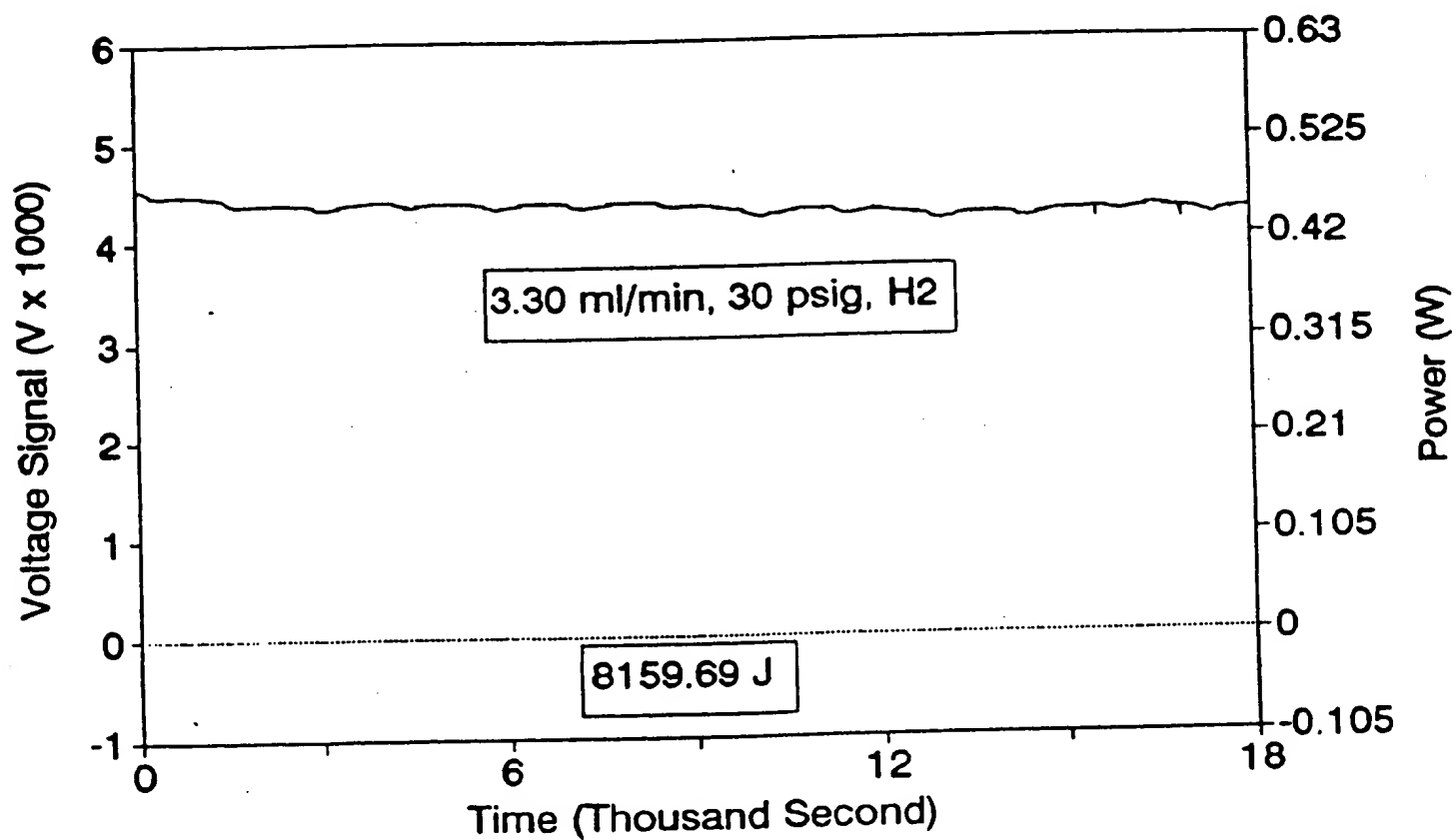


Fig. 23-6
H2 reaction 3 at 125 C (120495a)

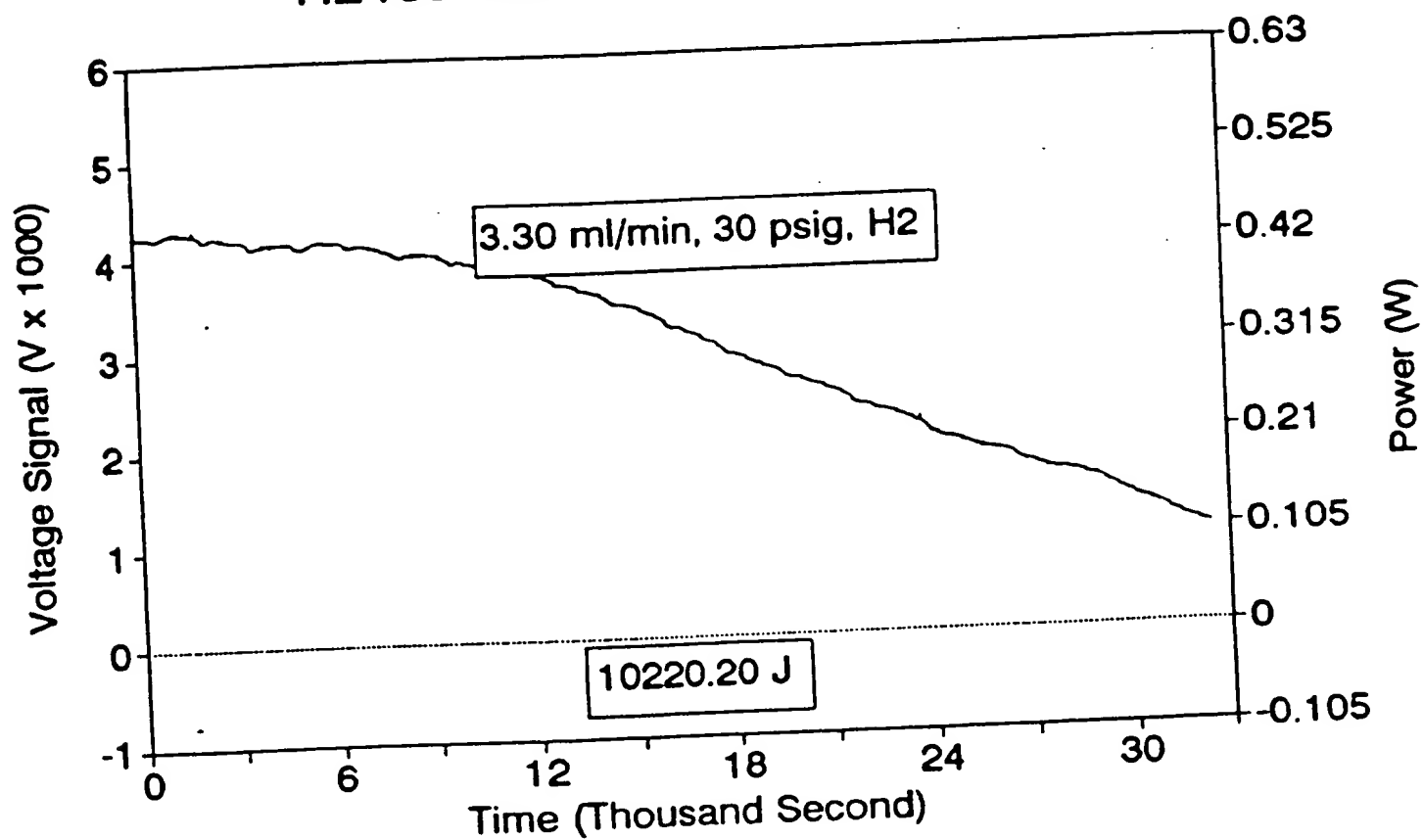


Fig. 23-7
H2 reaction 4 at 125 C (120495a)

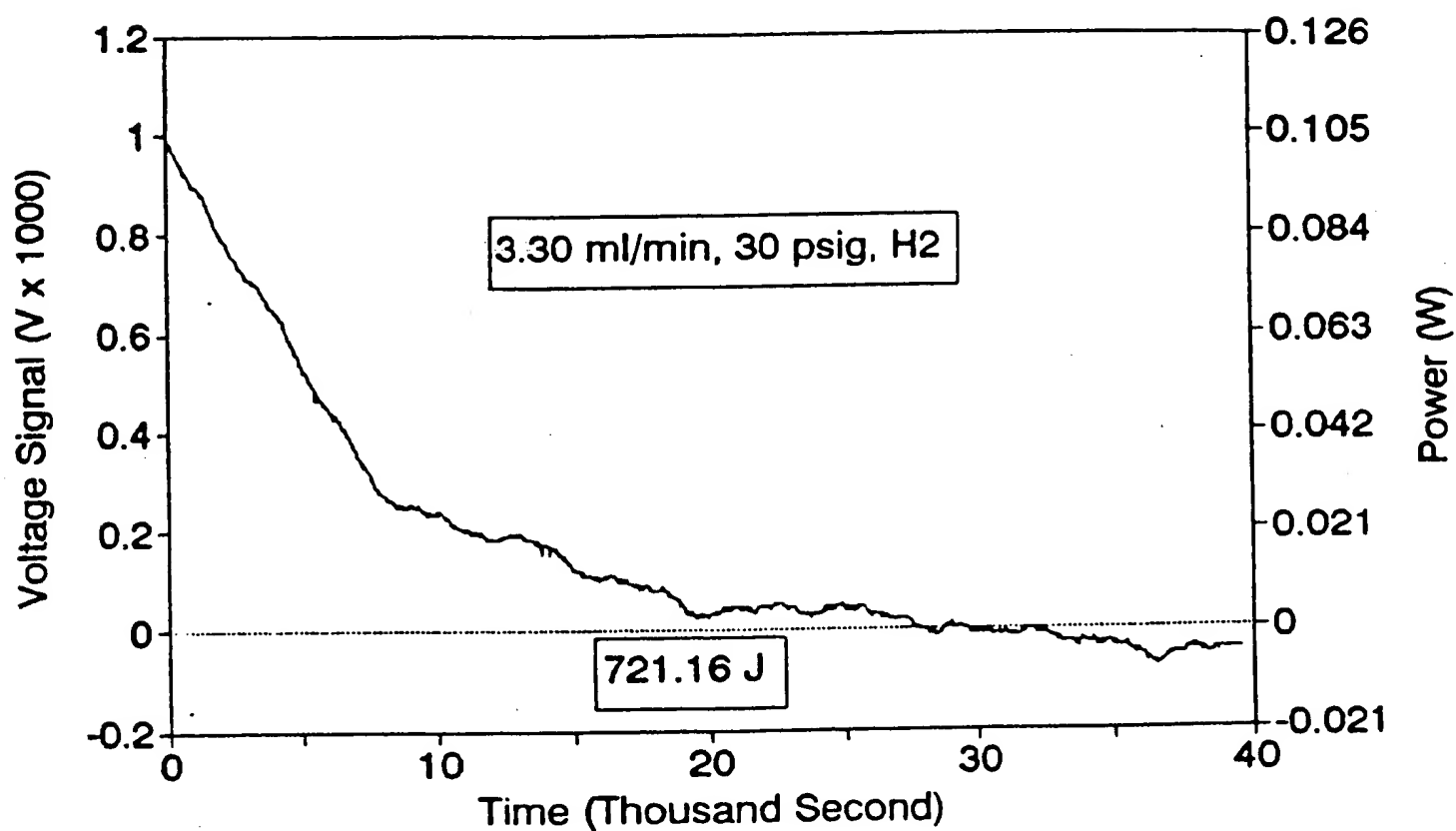


Fig. 23-8
Switch to (He+Air) at 125 C (120495a)

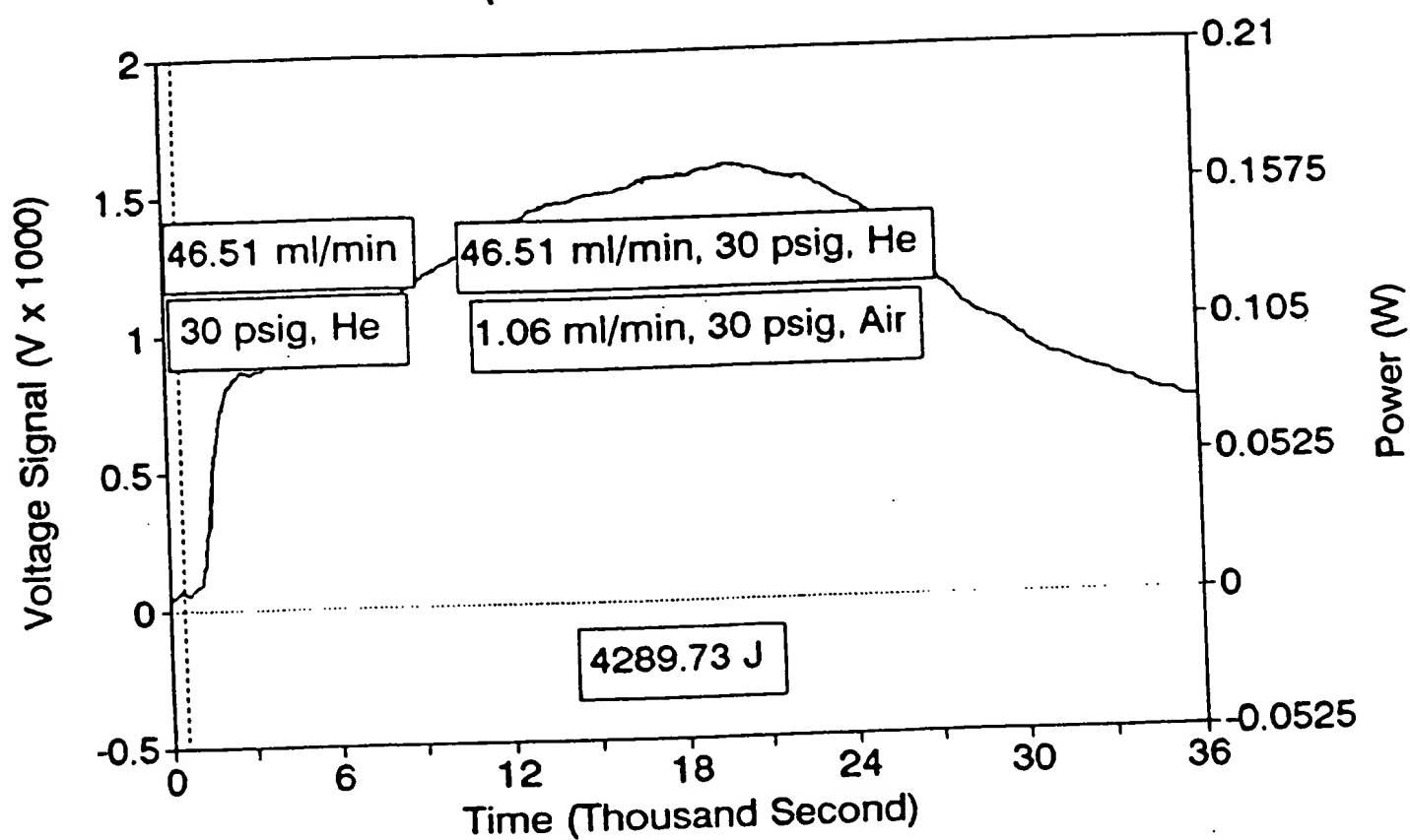


Fig. 23-9
Air reaction 1 at 125 C (120495a)

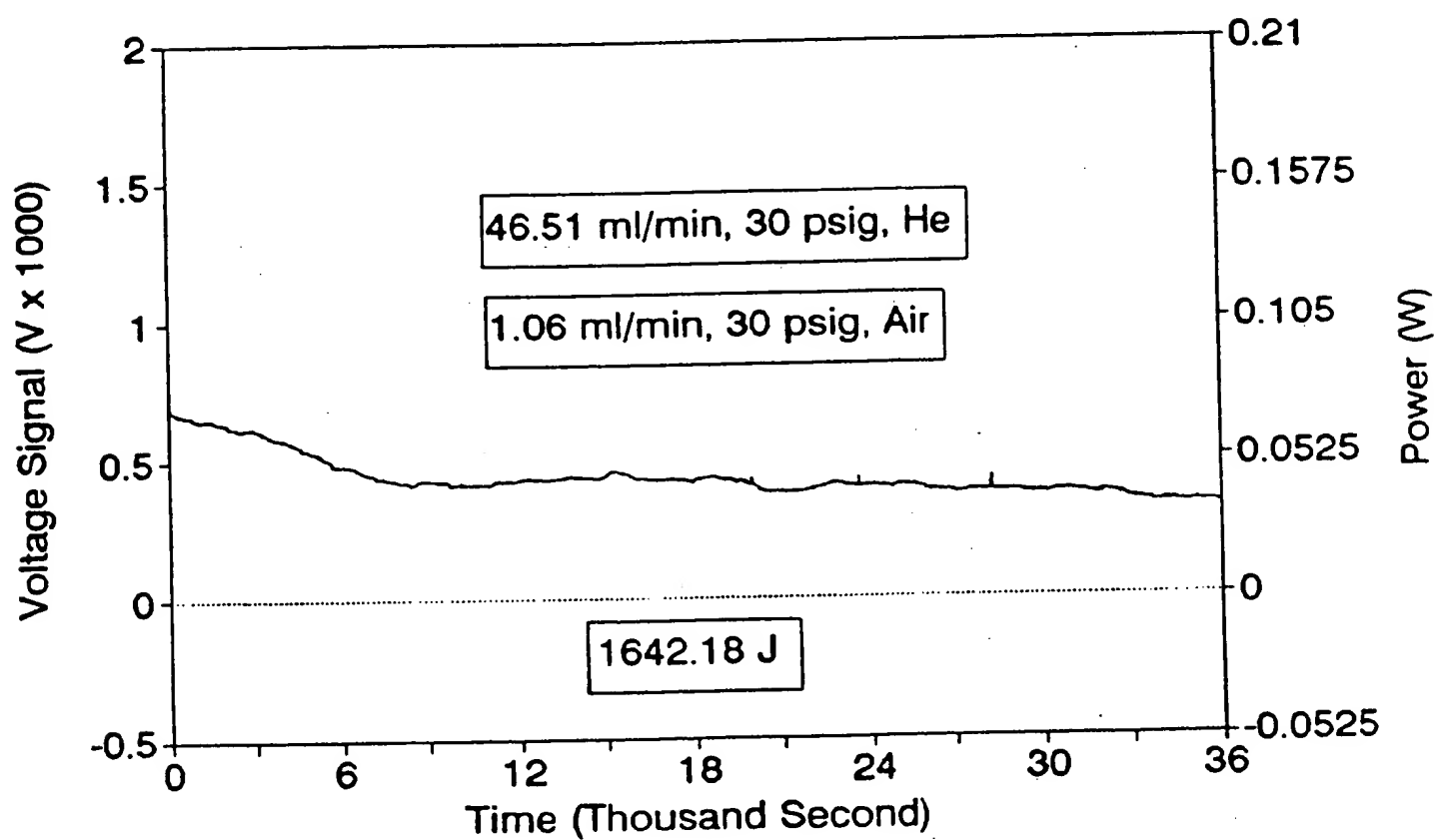


Fig. 23-10
Air reaction 2 at 125 C (120495a)

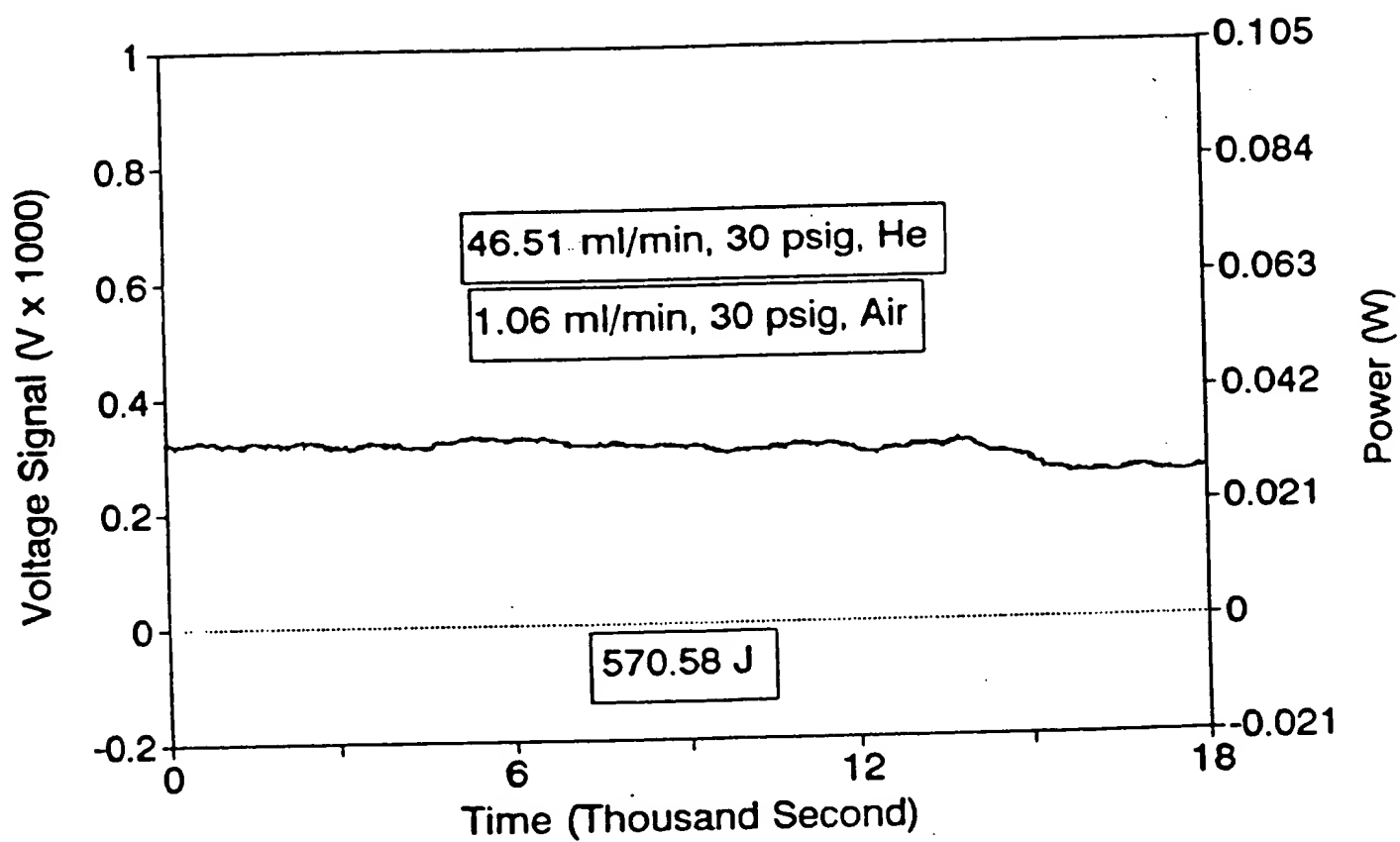


Fig. 23-11
Air reaction 3 at 125 C (120495a)

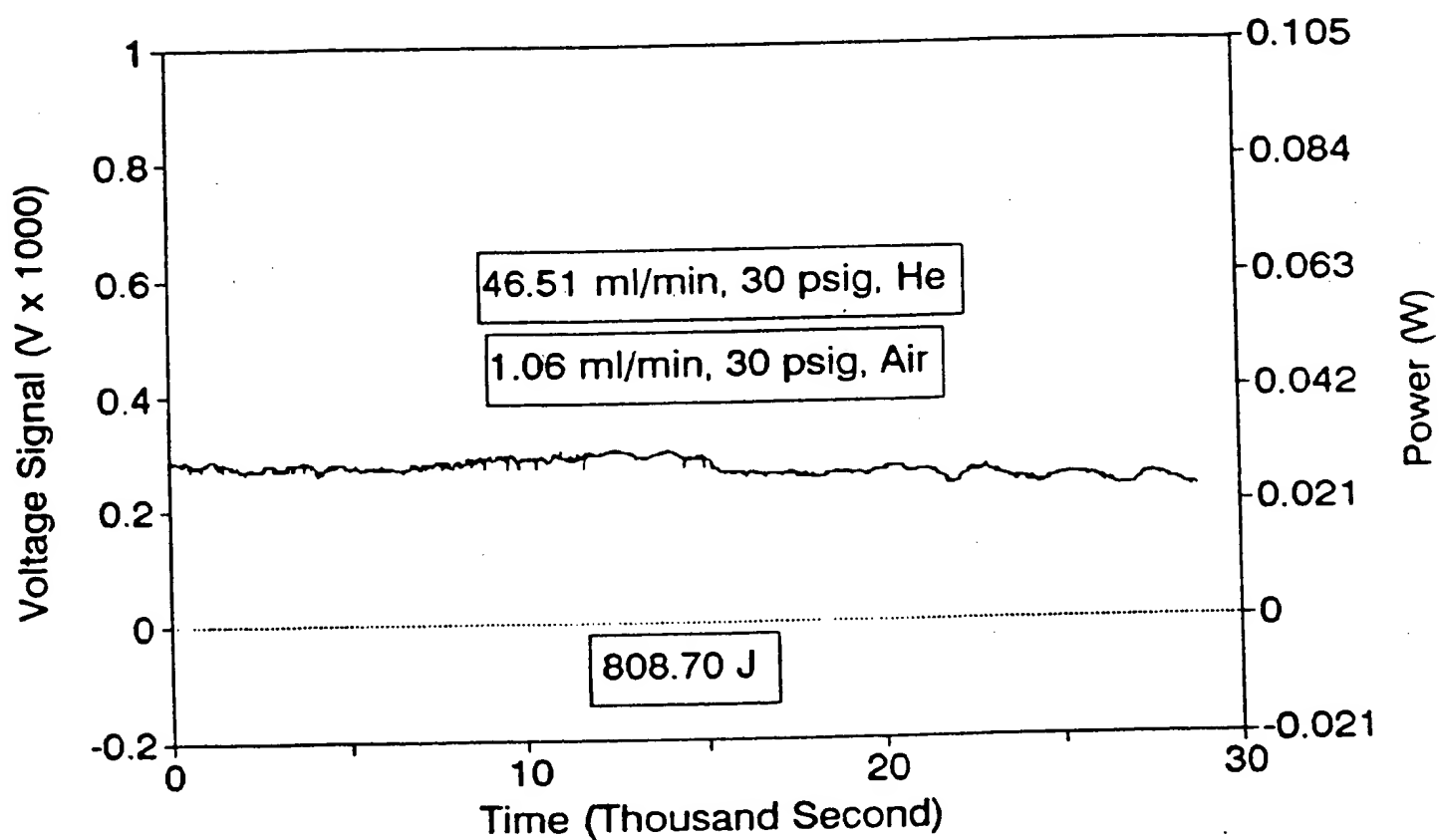


Fig. 23-12
Air reaction 4 at 125 C (120495a)

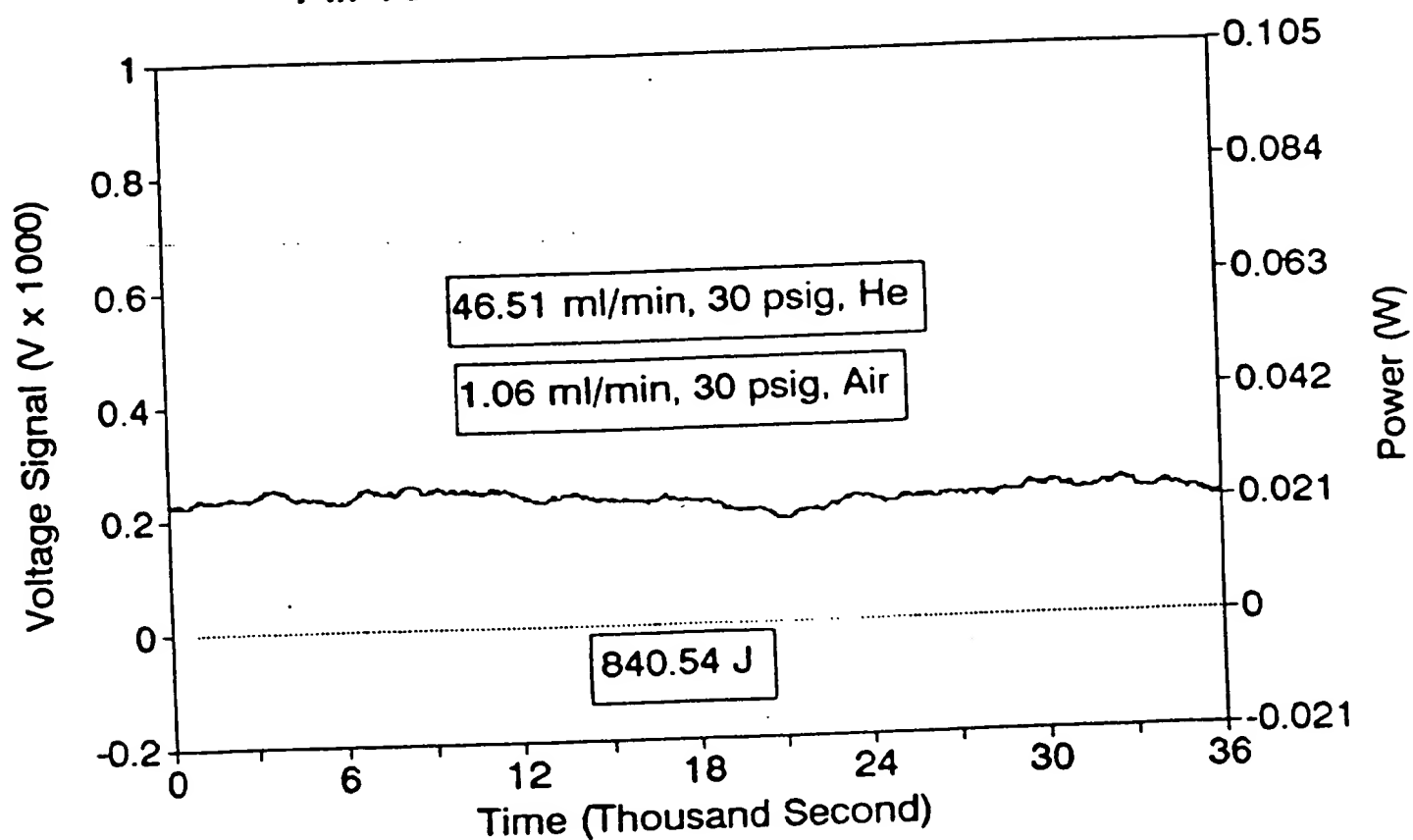


Fig. 23-13
Air reaction 5 at 125 C (120495a)

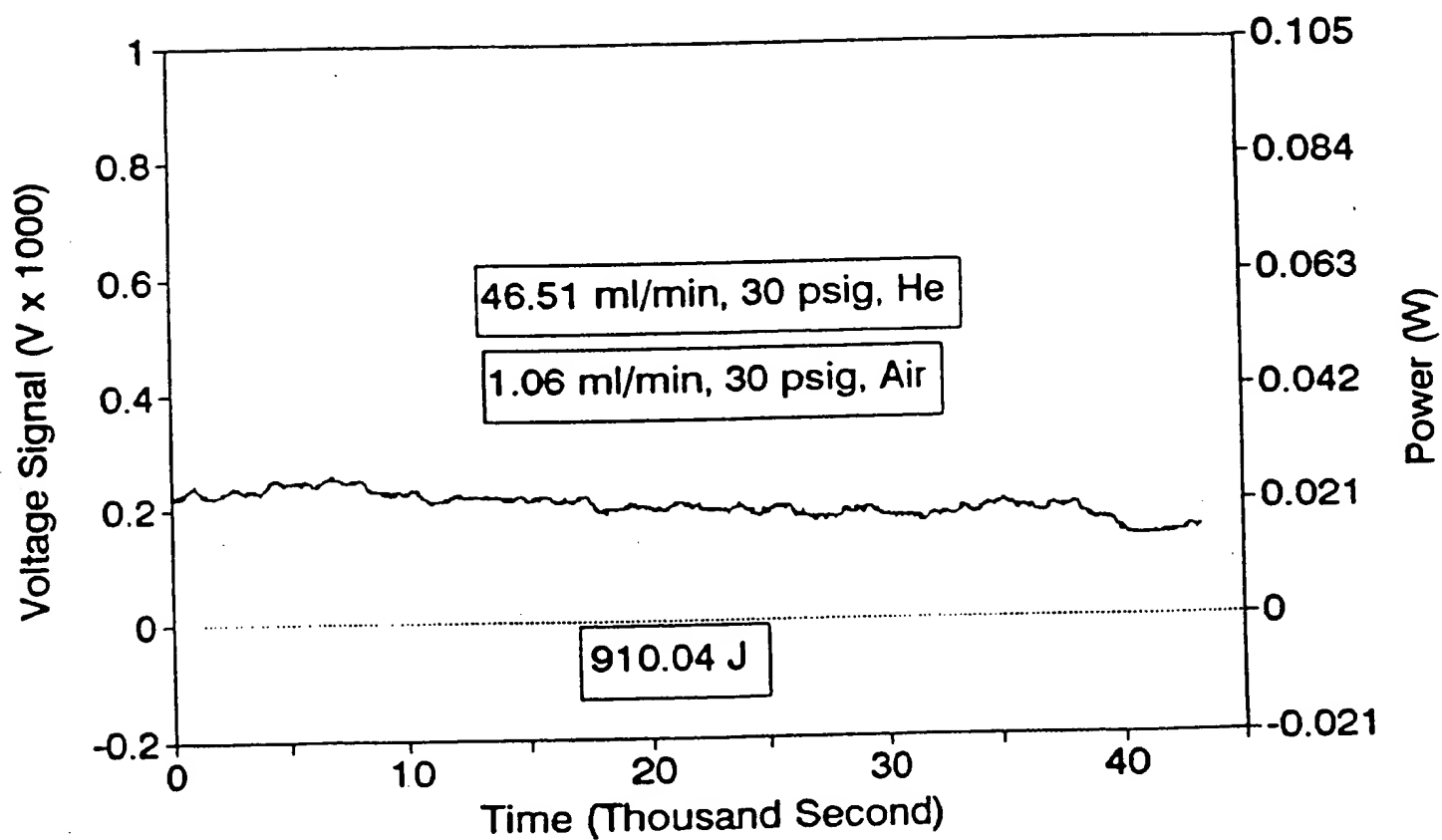


Fig. 23-14
Air reaction 6 at 125 C (120495a)

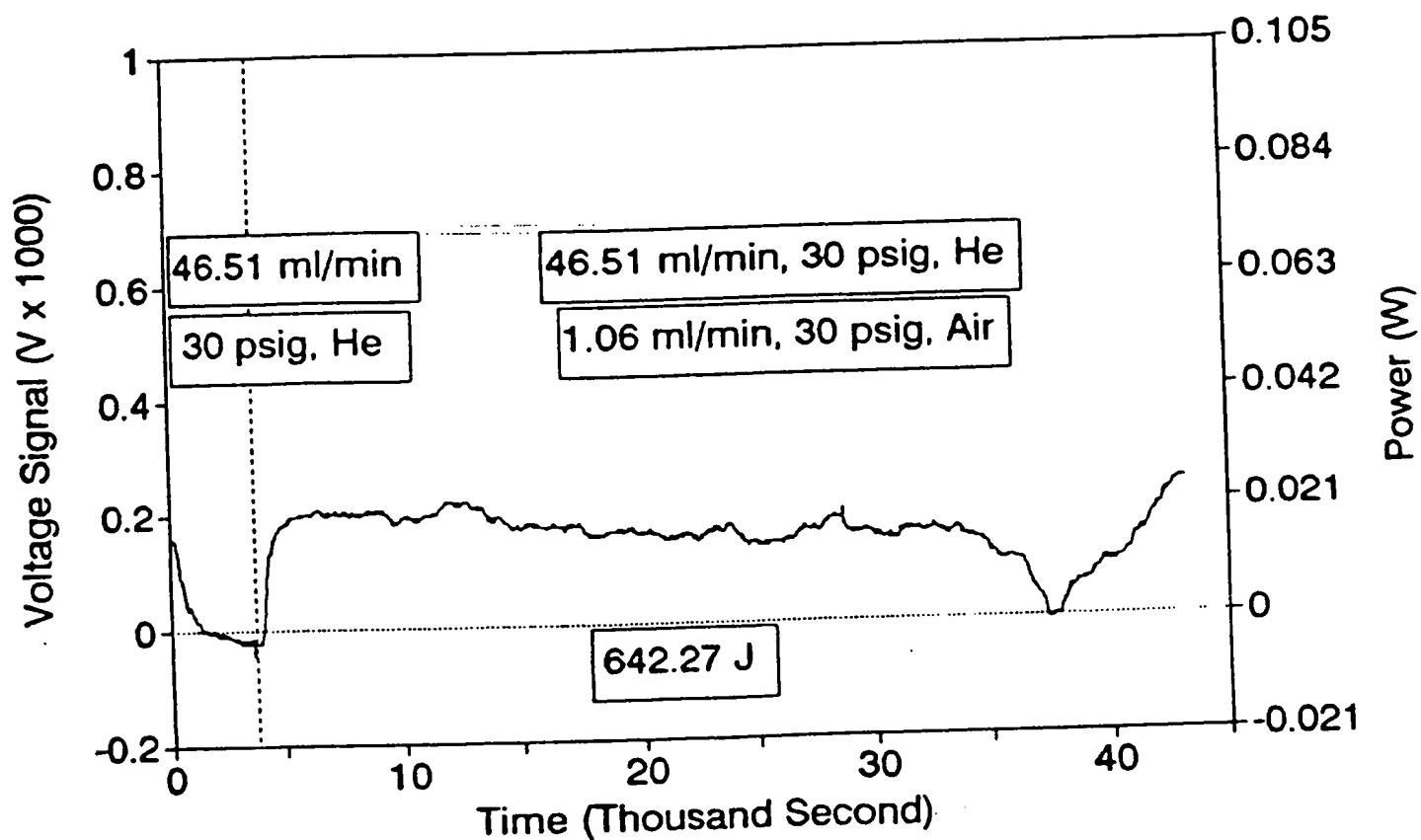


Fig. 23-15
Air reaction 7 at 125 C (120495a)

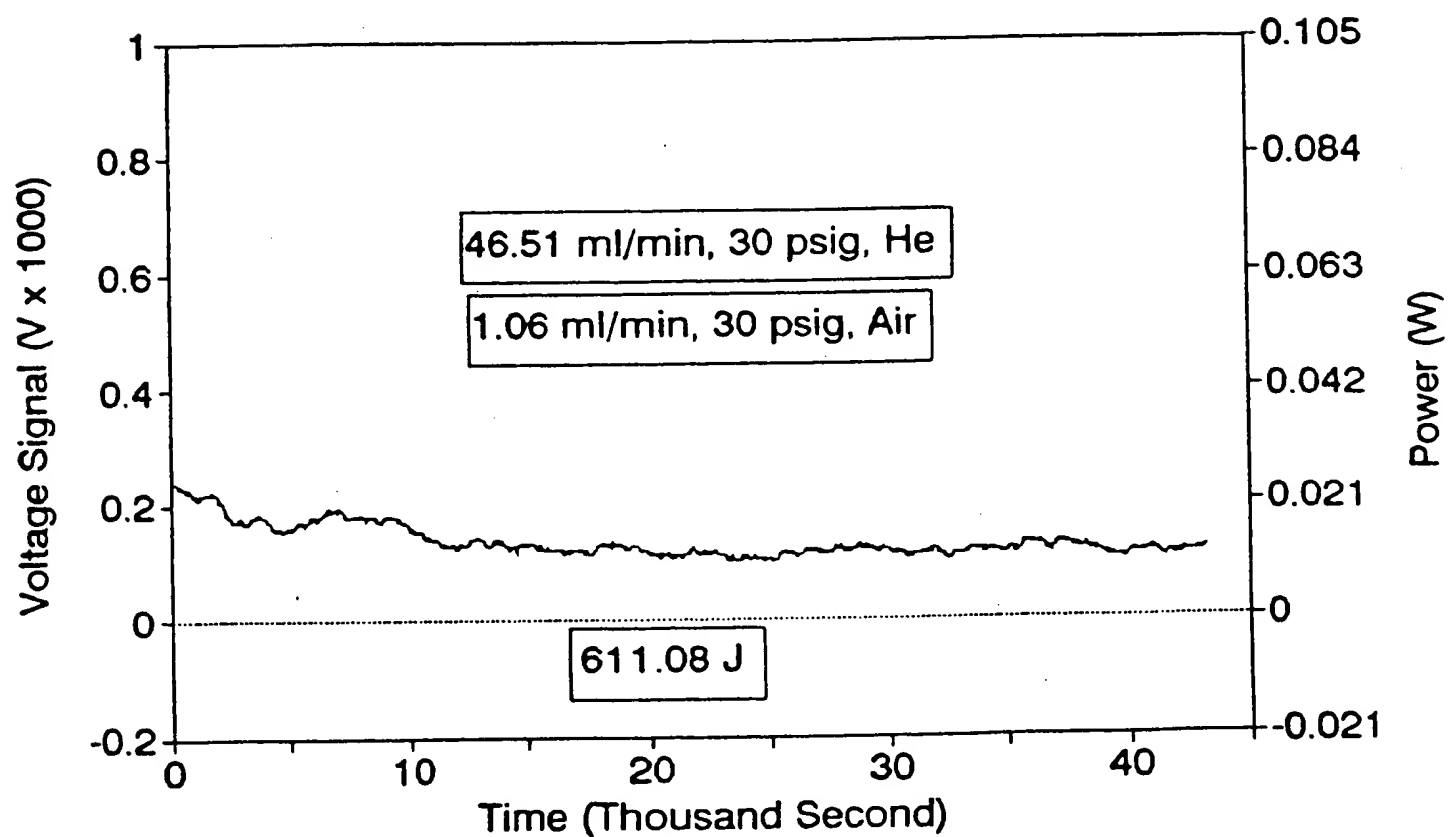


Fig. 23-16
Air reaction 8 at 125 C (120495a)

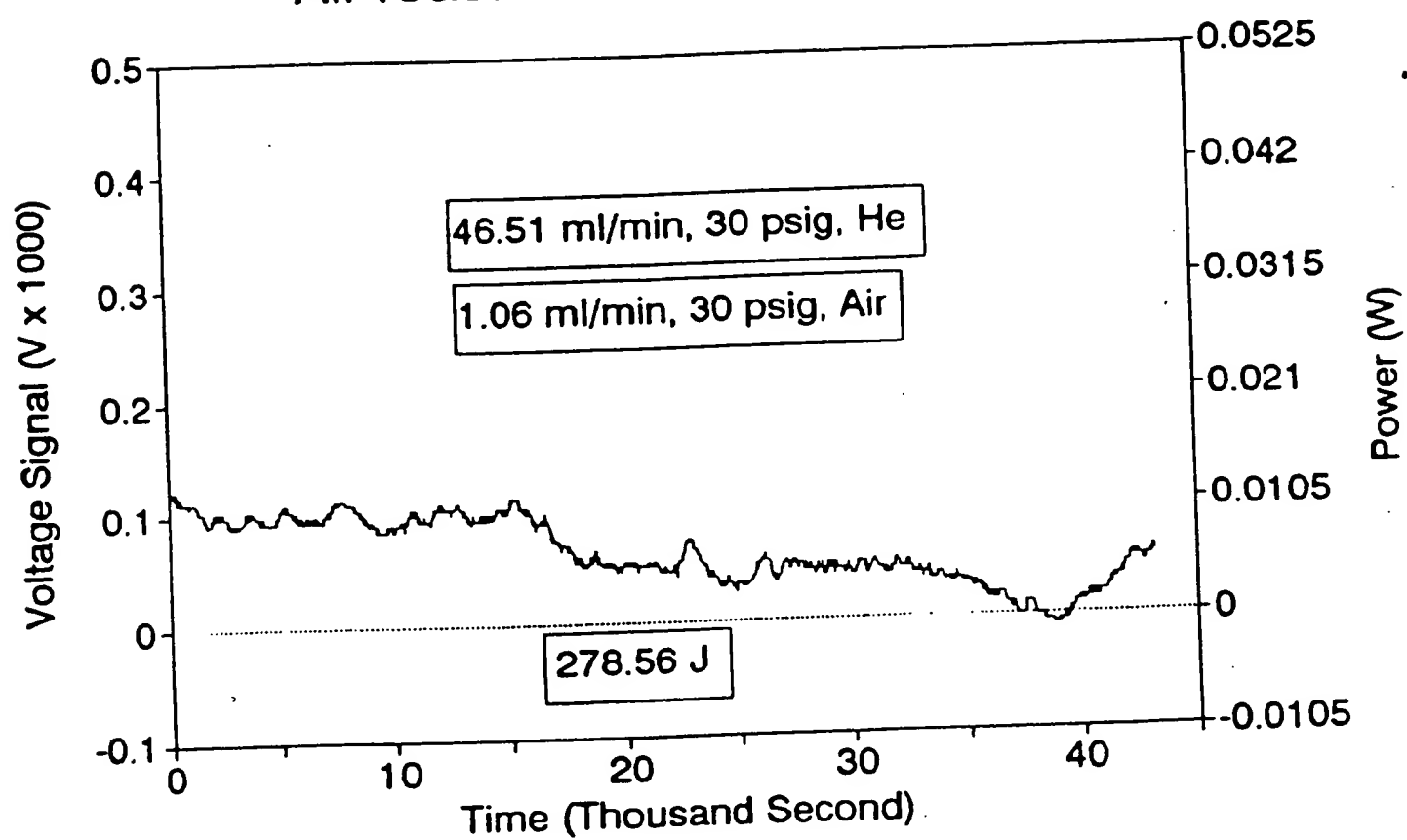
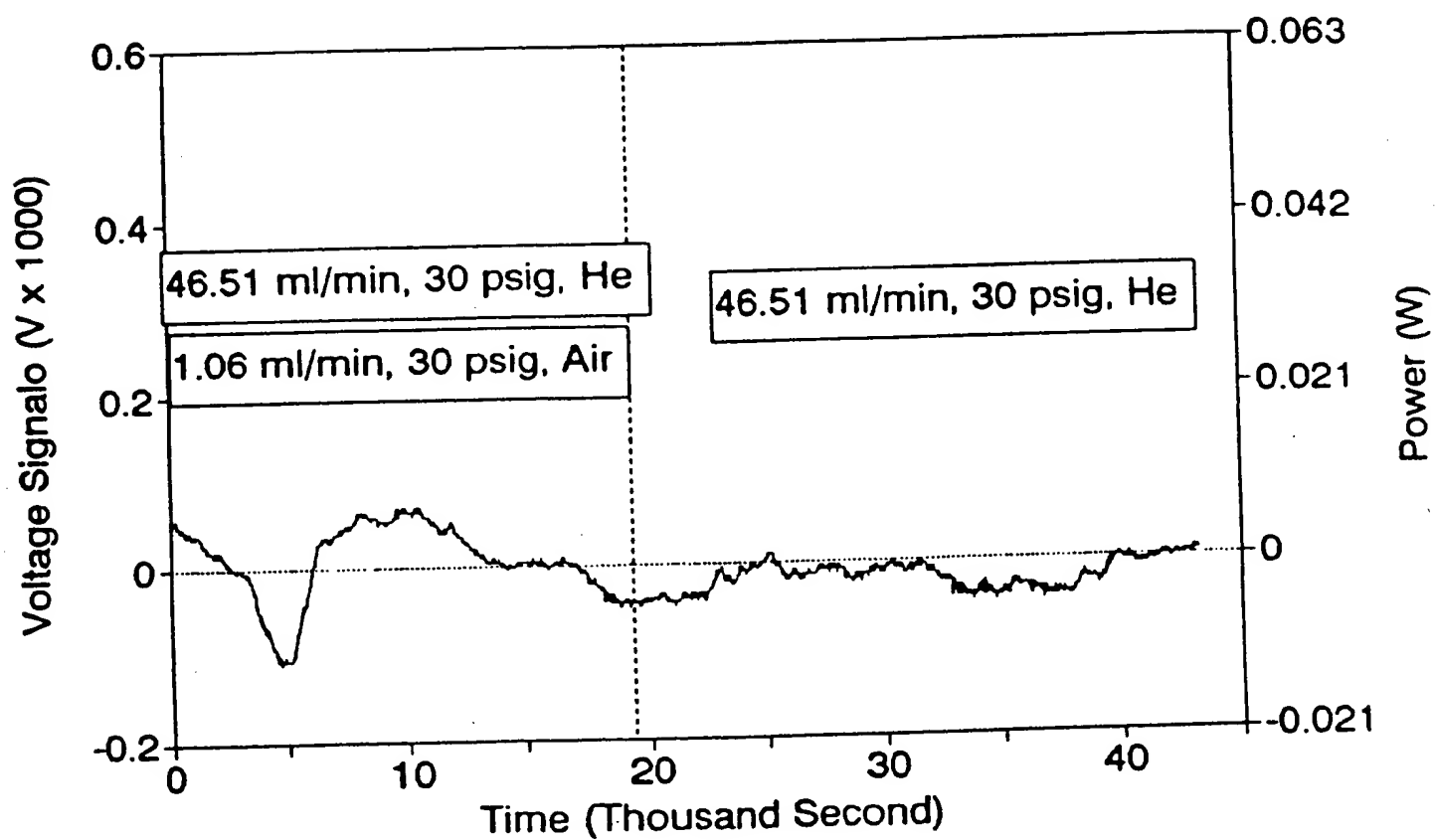


Fig. 23-17
Switch to He at 125 C (120495a)



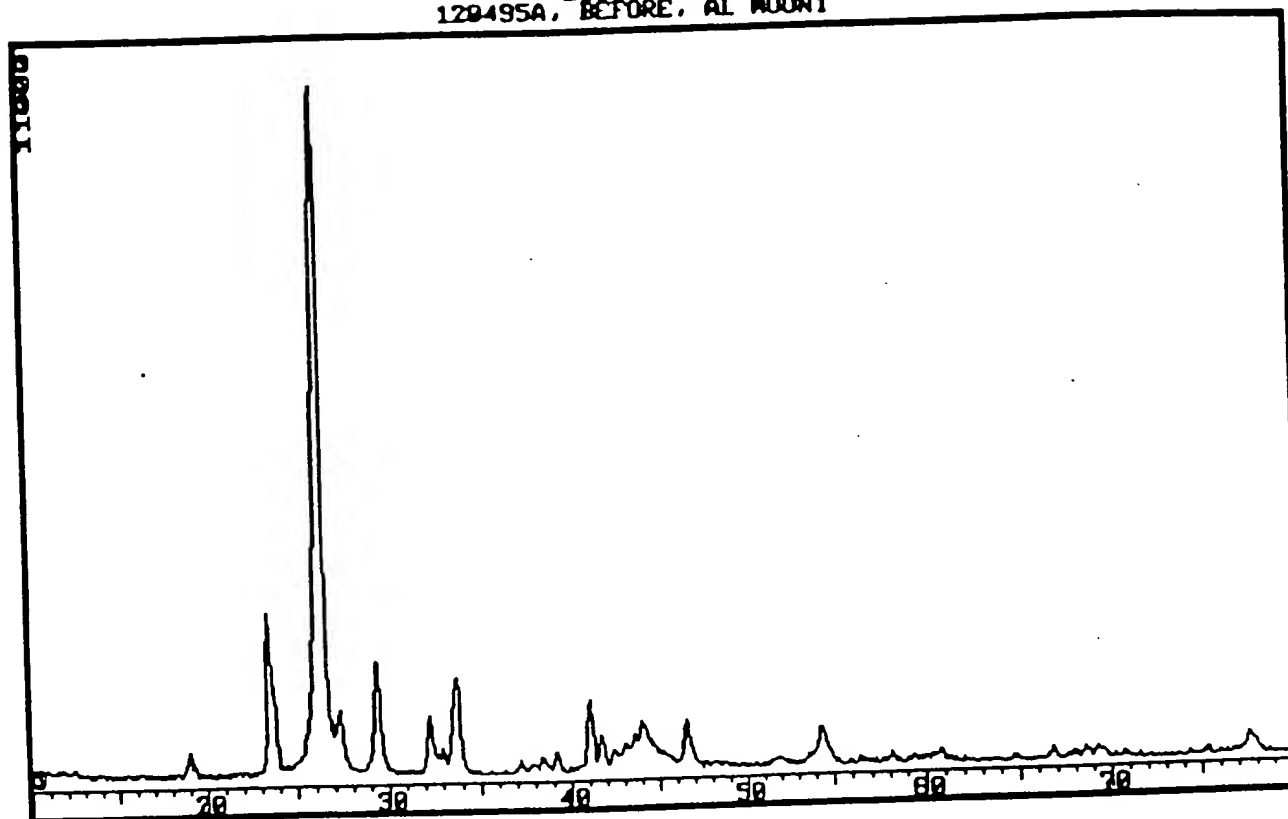
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23-18

120495 A

Before

213156.RAW
120495A, BEFORE, AL MOUNT

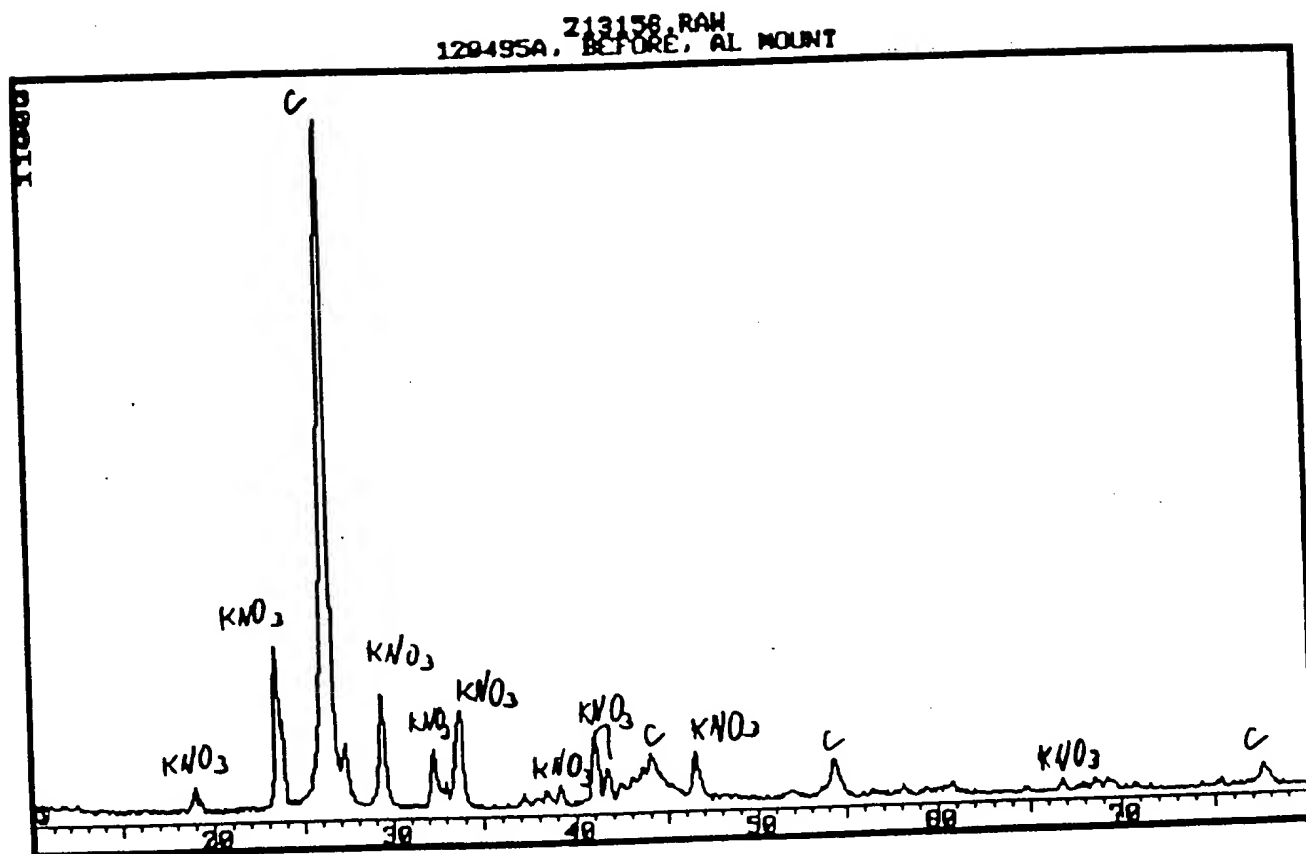


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23-19

120498A

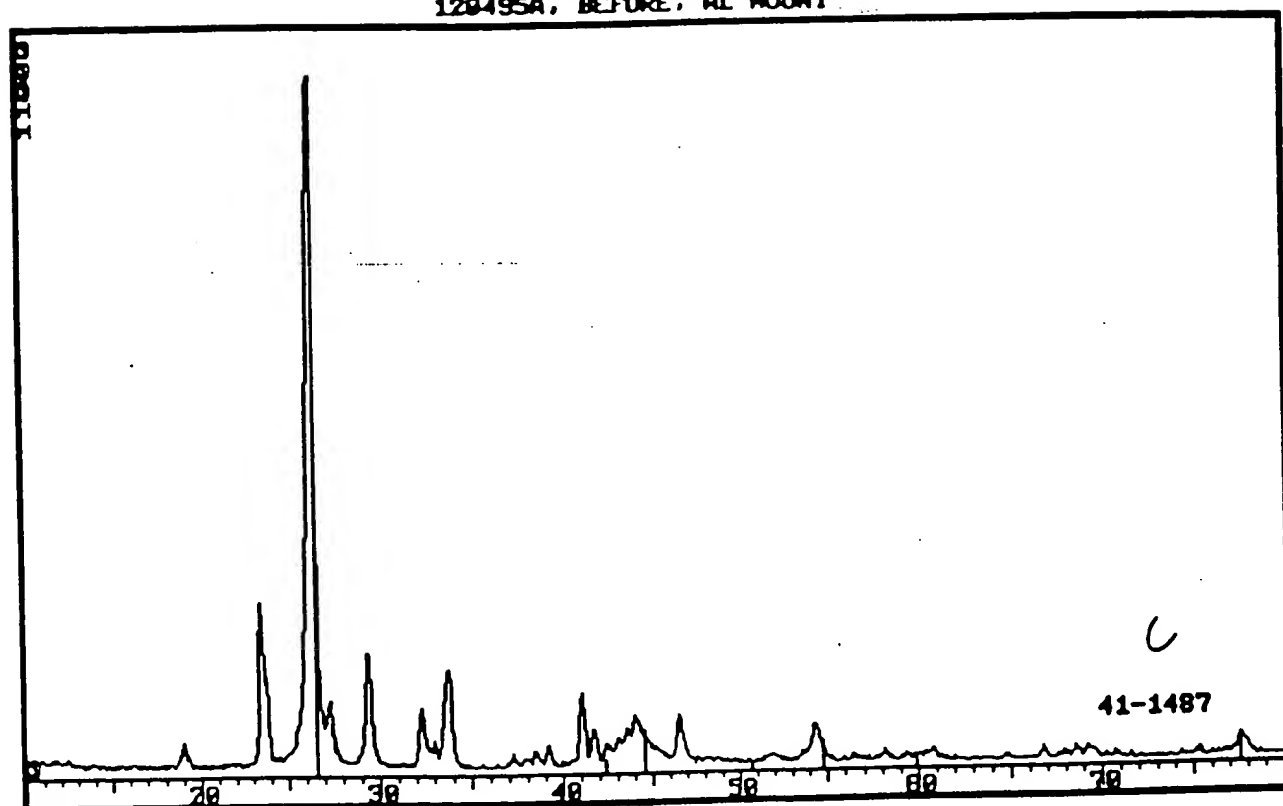
Before



12/24/95

23-20

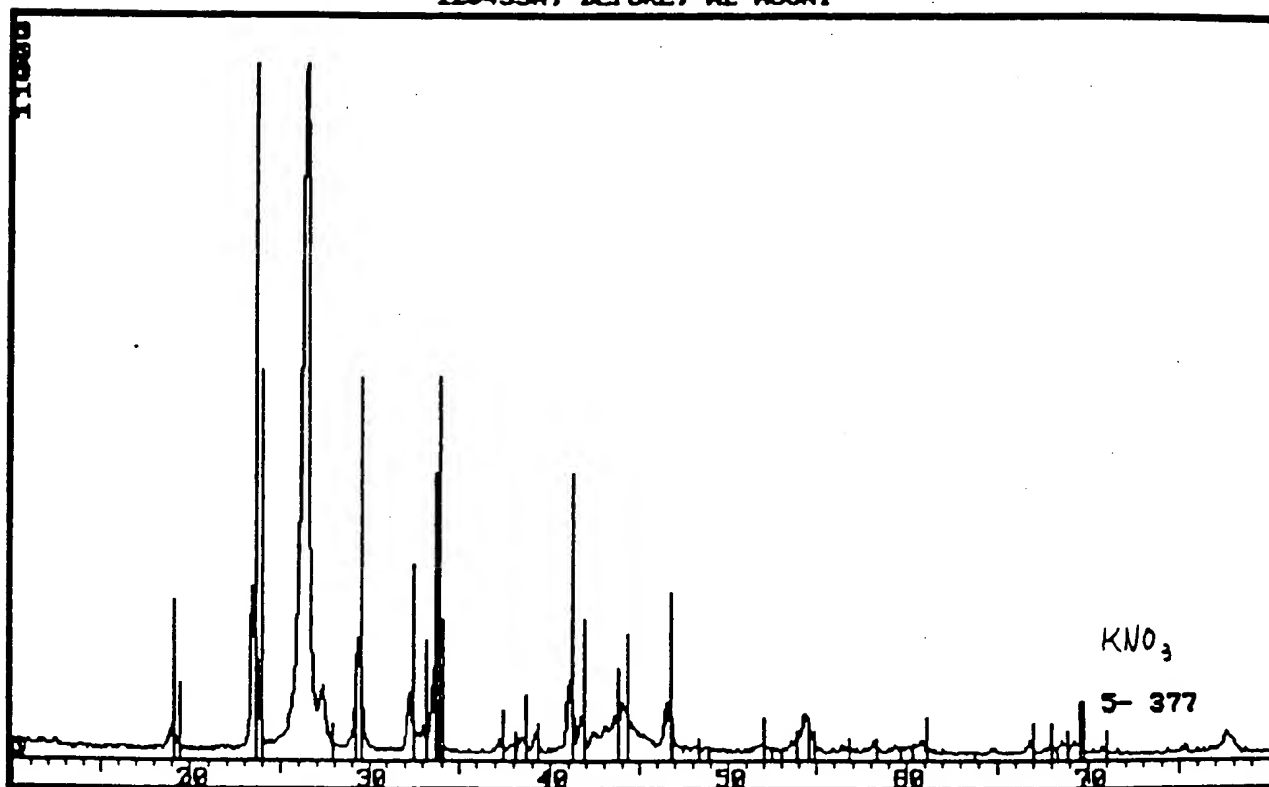
213156 RAW
120495A, BEFORE, AL MOUNT



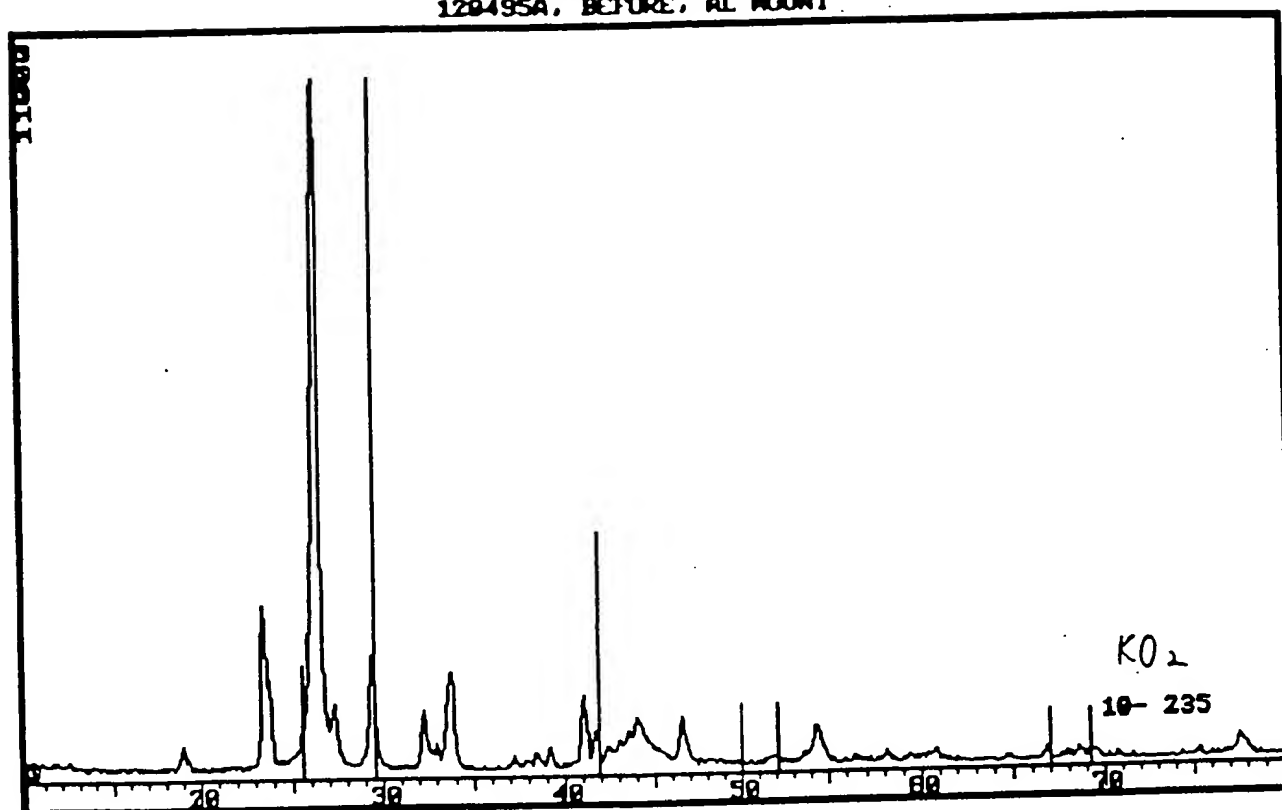
12/21 195

22.21

213158.RAW
128495A, BEFORE, AL MOUNT



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219158, RAW
129495A, BEFORE, AL MOUNT

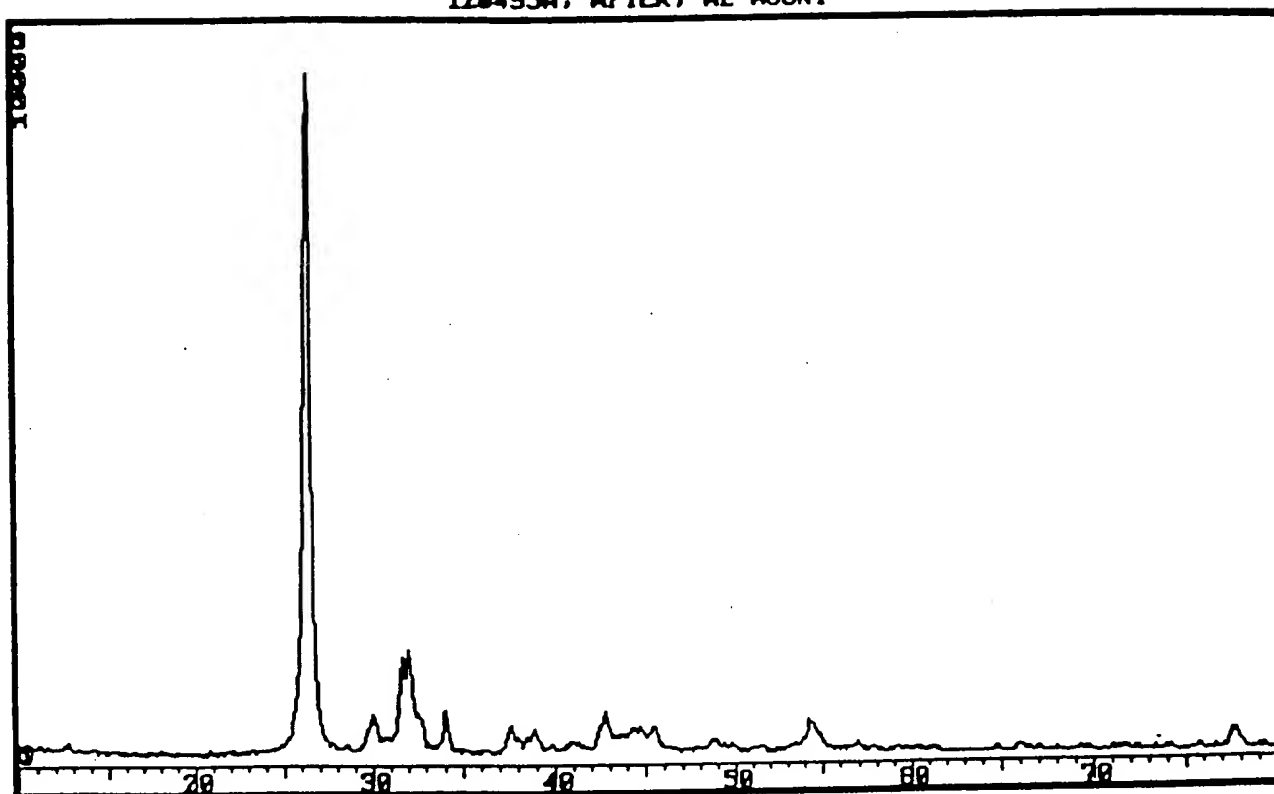
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23-23

120495 A

After

213155.RAW
120495A, AFTER, AL MOUNT

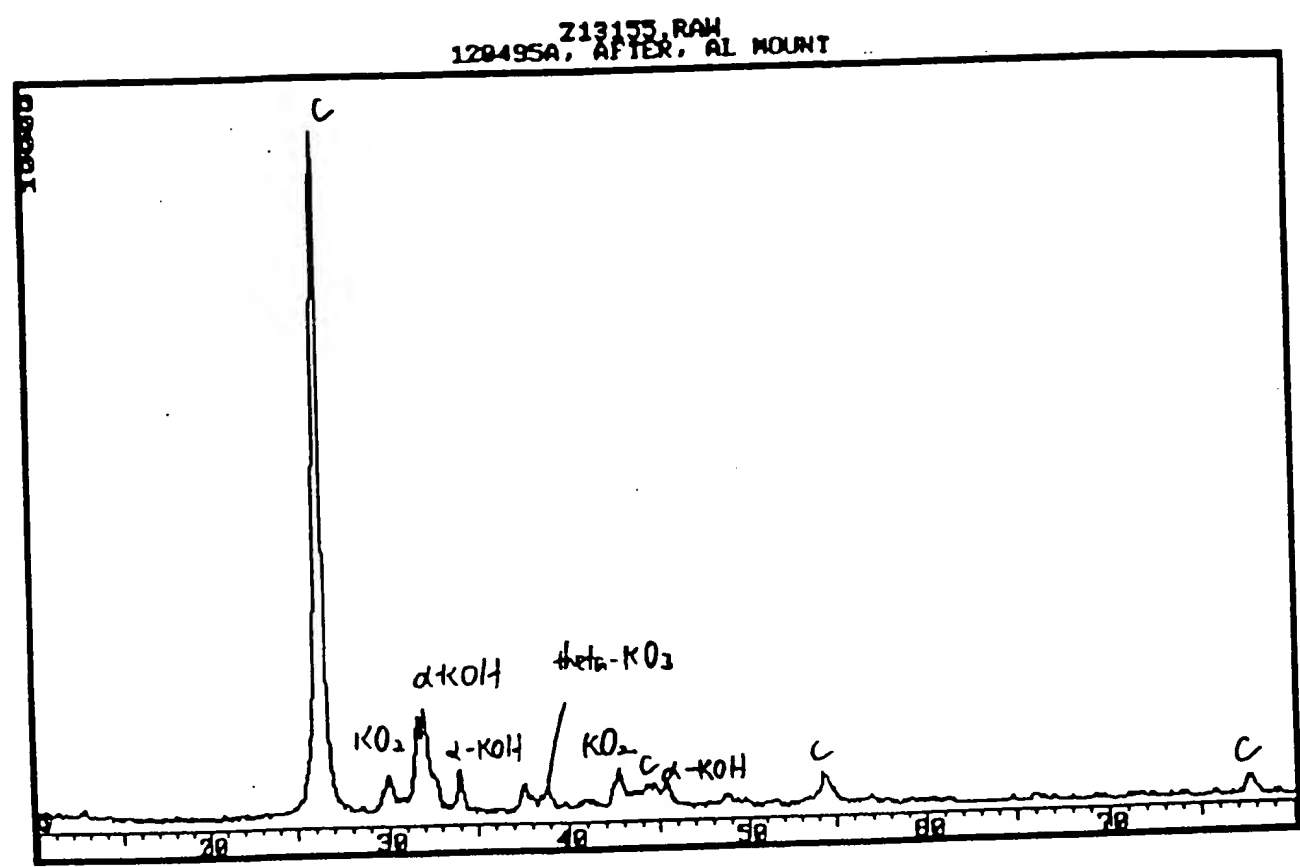


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23-24

120495 A

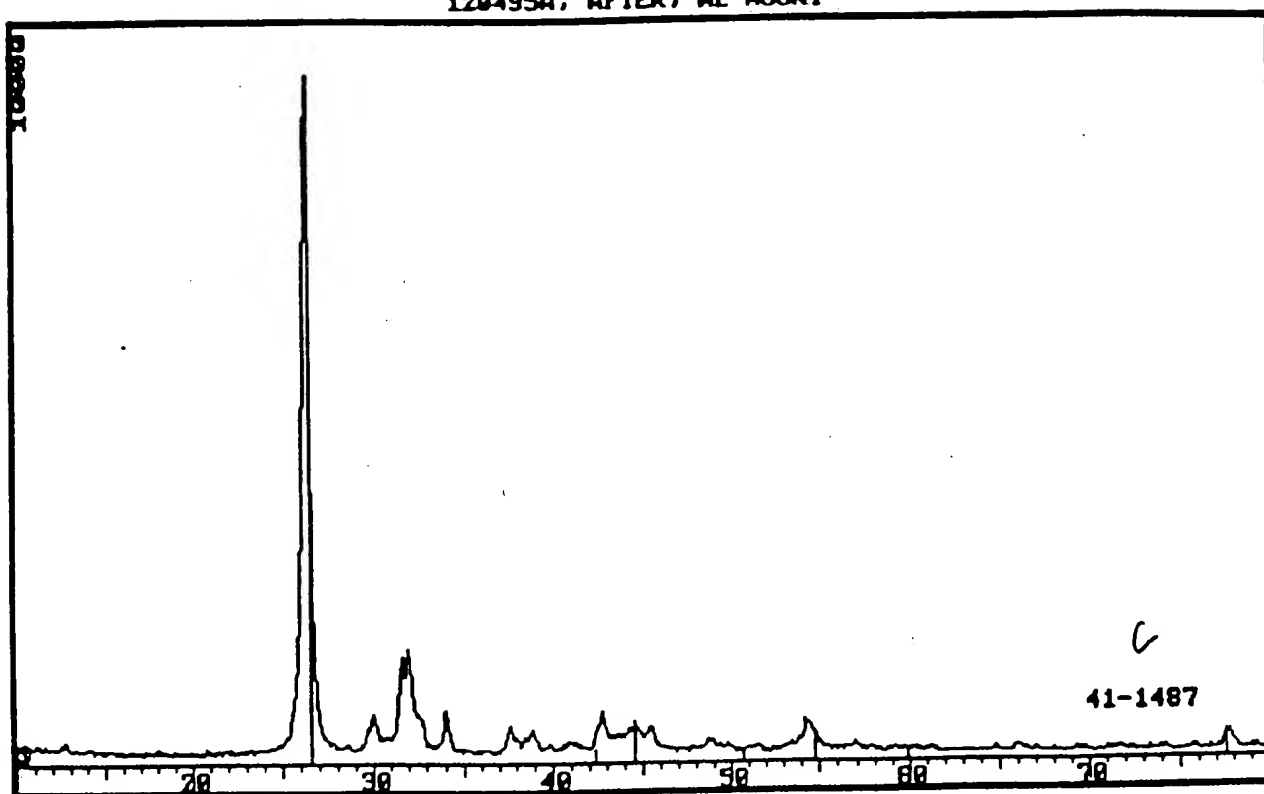
After



12/24/95

23-25

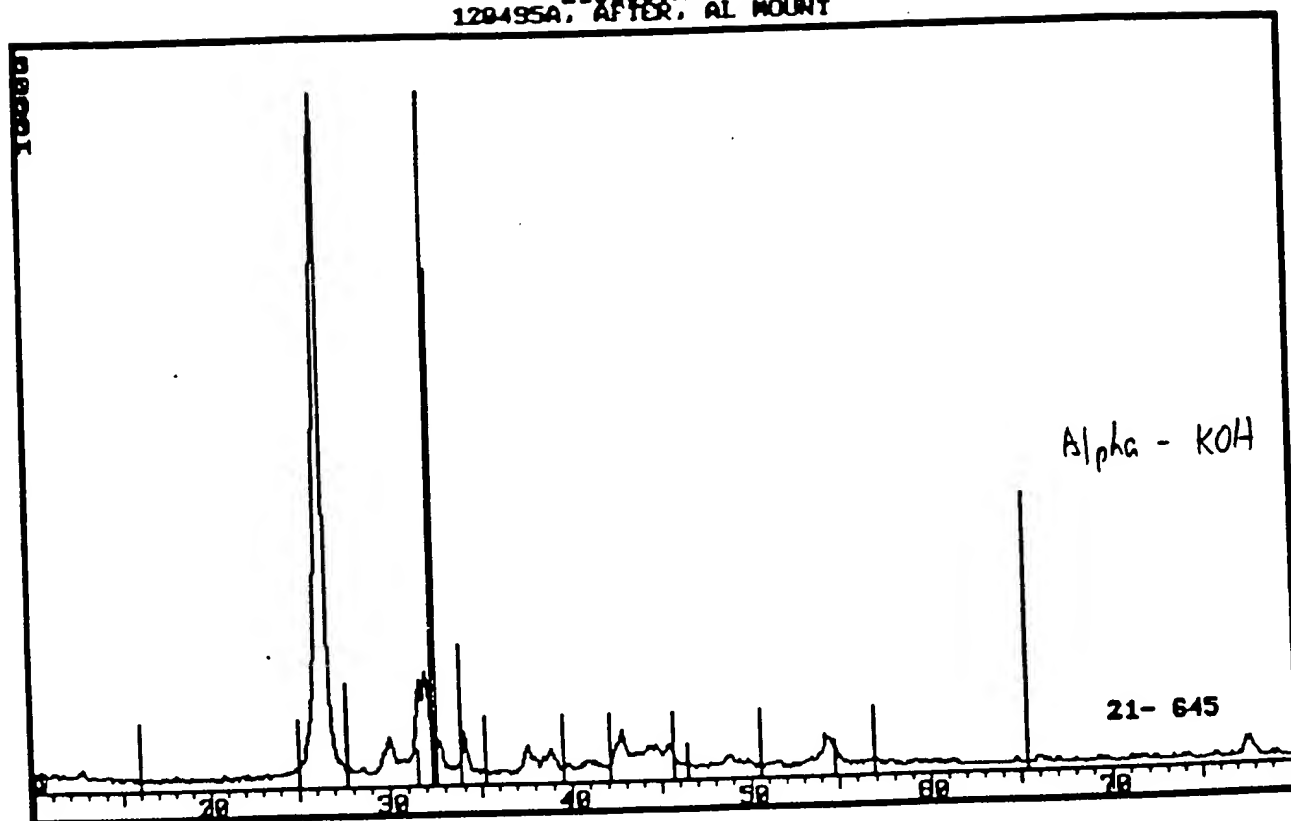
Z13155.RAW
120495A, AFTER, AL MOUNT



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23-25

213155, RAW
120495A, AFTER, AL MOUNT



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